CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

Volume 19 San Francisco, April, 1933 Number 2

25c per copy $1.00 per year

TROUT NUMBER

1619

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF FISH AND GAME

San Francisco, California

Fish and Game Commissioners appointed by the Governor. Term at pleasure of Governor. No compensation

J. DALE GENTRY, President ..... San Bernardino
EARL B. GILMORE, Commissioner ..... Los Angeles
I. ZELLERBACH, Commissioner ..... San Francisco
JOHN L. FARLEY, Executive Officer ..... San Francisco
E. Lingenfelder, Assistant Executive Officer ..... Los Angeles
EUGENE D. BENNETT, Attorney ..... San Francisco

450 McAllister Street. Phone Underhill 8700

BUREAU OF FISH CULTURE

J. O. SNYDER, Chief ..... San Francisco
W. H. Shebley, Fish Cultural Adviser ..... Sacramento
J. H. Vogt, Assistant to Chief of Bureau ..... San Francisco
A. E. Burghduff, Field Superintendent ..... San Francisco
L. Phillips, Field Superintendent ..... San Francisco
E. V. Cassell, Superintendent of Mt. Shasta Hatchery ..... Mt. Shasta
Geo. McCloud, Superintendent Mt. Whitney Hatchery ..... Independence
D. A. Clanton, Superintendent Forest Home Hatchery ..... Forest Home
J. C. Lewis, Superintendent Fort Seward Hatchery ..... Alderpoint
Earl Leitritz, Foreman Fall Creek Hatchery ..... Copco
Peter Topp, Foreman Yosemite Hatchery ..... Yosemite
C. L. Frame, Foreman Big Creek Hatchery ..... Davenport
J. W. Ricker, Foreman Cold Creek Hatchery ..... Ukiah
H. E. Cole, Foreman Feather River Hatchery ..... Clio
Ed Clessen, Foreman Kaweah Hatchery ..... Three Rivers
George E. West, Foreman Tahoe Hatchery ..... Tahoe
Wm. Berrian, Foreman Lake Almanor Hatchery ..... Chester
L. C. Dockham, Foreman Basin Creek Hatchery ..... Tuolumne
Archie Thompson, Foreman Burney Creek Hatchery ..... Burney
K. H. Shebley, Foreman Kings River Hatchery ..... Fresno
Guy C. Tabler, Foreman Yuba River Hatchery ..... Camptonville
John Marshall, Foreman Brookdale Hatchery ..... Brookdale
James L. Stinnett, Foreman Klamath River Stations ..... Gottville
William Fiske, Acting Foreman, Mt. Whitney Hatchery ..... Independence
Ross McCloud, General Foreman Mt. Shasta Hatchery ..... Mt. Shasta
Donald Evins, Superintendent Distribution Car 01 ..... Mt. Shasta
L. Rider, Superintendent Distribution Car 02 ..... Mt. Shasta

BUREAU OF COMMERCIAL FISHERIES

N. B. SCOFIELD, Chief ..... San Francisco
S. H. Dado, Assistant Chief ..... San Francisco
H. B. Nidever, Field Inspector ..... San Francisco
L. G. Van Vorhis ..... Terminal Island
W. L. Scofield, Director State Fisheries Laboratory ..... Terminal Island
W. F. Thompson, Consultant State Fisheries Laboratory ..... Terminal Island

BUREAU OF FINANCE AND ACCOUNTS

H. R. DUNBAR, Chief ..... Sacramento

BUREAU OF EDUCATION AND RESEARCH

LEO K. WILSON, Chief ..... San Francisco
Opie L. Warner, Publicist ..... San Francisco
Dr. M. Hobmaier, Pathologist ..... San Francisco
Paul A. Shaw, Toxicologist ..... San Francisco
Jack Boaz, Lecturer ..... Los Angeles
Bessie W. Kibbe, Librarian ..... San Francisco

BUREAU OF GAME REFUGES

J. S. HUNTER, Chief ..... San Francisco
Jay C. Bruce, State Lion Hunter ..... San Lorenzo
D. D. McLean, Field Naturalist ..... San Francisco
A. D. McLellan, Game Refuge Supervisor ..... San Francisco

BUREAU OF HYDRAULICS

JOHN SPENCER, Chief ..... San Francisco
Clarence Elliger, Assistant ..... San Francisco
E. A. Chan ..... Long Beach

BUREAU OF GAME FARMS

AUGUST BADE, Chief ..... Yountville
E. D. Platt, Assistant in Charge ..... Chino
Gordon H. True, Jr., Field Production of Game ..... San Francisco

BUREAU OF FISH RESCUE AND RECLAMATION

GEORGE NEALE, Chief ..... Sacramento

CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION."

VOLUME 19 SACRAMENTO, APRIL, 1933 No. 2

CONTENTS

CALIFORNIA TROUT.....*John O. Snyder* 81

THE CALIFORNIA TROUT INVESTIGATIONS.....*P. R. Needham, Ph.D.* 113

METHODS FOR COUNTING SMALL FISH IN HATCHERIES.....*A. C. Taft* 122

DESTRUCTION OF WILD LIFE IN THE MATILIJA FIRE..*W. I. Hutchinson* 126

DESCRIPTION OF A GIANT SQUID TAKEN AT MONTEREY, WITH NOTES ON OTHER SQUID TAKEN OFF THE CALIFORNIA COAST..*J. B. Phillips* 128

CHANGING ABUNDANCE OF THE CALIFORNIA SARDINE, MEASURED BY LENGTH OF SCOUTING TIME.....*Frances N. Clark* 136

REPORT OF THE COMMISSIONERS OF FISHERIES OF THE STATE OF CALIFORNIA FOR THE YEARS 1872 AND 1873..... 142

EDITORIALS 155

COMMERCIAL FISHERY NOTES..... 156

DIVISION ACTIVITIES 159

REPORTS—

STATEMENT OF INCOME..... 163

STATEMENT OF EXPENDITURES..... 164

VIOLATIONS OF FISH AND GAME LAWS..... 166

FISHERY PRODUCTS, OCTOBER, NOVEMBER AND DECEMBER, 1932..... 168

CALIFORNIA TROUT

By JOHN O. SNYDER

ANGLERS from the time of Walton have sung the praises of the trout. They have set it apart from among the fishes because of its beauty of form and color, its shy and wary disposition, its tremendous energy and fighting spirit, its delicious food qualities, and above all its association with the placid pools of the valley streams and the sparkling, turbulent waters of the forested hills and snowy peaks. To the more thoughtful comes an appeal to muse on the apparent vagaries of nature which allow the trout to dress in modest browns and olives in boggy waters, in silvers and blues in alpine lakes, or in a veritable riot of scarlet and gold in the plunging streams of the mountain slopes.

DISTRIBUTION AND RELATIONSHIPS

The trouts are all more or less boreal fishes, and where they have succeeded in extending their distribution over any considerable area in the direction of the tropics they have taken advantage of alpine, i. e. high mountain conditions. The most southerly American species is the rainbow trout of the San Pedro Martir Mountains of lower California, where a relatively few individuals representing an isolated species exist in a precarious situation. They are the last survivors of a time when through more favorable climatic conditions trout were abundant in the southern coastal region where they are now rare or entirely extinct. Their presence calls attention to a period in the remote past when steelheads from the sea entered streams far south of our borders and spawned in the mountain tributaries. The San Pedro Martir trout are now permanently cut off from the ocean, being unable to accomplish a safe passage through the sub-tropical lower course of the stream in which they live. A somewhat similar case, but with less complete isolation, is furnished by the native trout of the San Bernardino Mountains. Trout in situations such as these are isolated much as are humans on oceanic islands. There is no way to escape or spread, neither is there an opportunity under natural conditions for contamination of the breed or strain by blood from the outside. Under such circumstances, forms whether fish or humans, tend to differentiate and assume peculiarities which ultimately serve to distinguish them, and they come to be known to us as distinct species or races. For convenience we give them names, scientific or common.

Although boreal in their habitat and fluvial in derivation, trout have come to adapt themselves to life in the ocean, being anadromous fishes where conditions permit. They also have invaded the lakes and accommodated themselves to considerable depths. However, they have not in any case entirely broken away from their ancient fluvial heritage in that cool, rapid, and well aerated water is necessary for their early life.

The trouts belong to a great and ancient family, the Salmonidae, fishes that have not attained a high degree of anatomical specialization. Their general structure and external appearance are simply fish-like. They bear no special armor such as plates or spines, no particular or peculiar fin structures, no dermal tentacles, barbels or fantastic ornaments. The Salmonidae occupy a position in the zoological classification of fishes somewhat midway between the sharks with their simple and primitive skeletons of cartilage, and the higher fishes as the basses or cods, which possess a bony framework of great complexity. The trout, none the less, have specialized in one particular, that of bodily color, in which some of them rival the most brilliant productions of the tropical seas.

The Salmonidae are represented in the waters of California as follows:

Native Species

Salmon *Oncorhynchus;* four species—King, Silver, Humpback and Dog. The king and silver are of commercial and sporting importance. The others are scarcely ever seen.

Trout *Salmo;* many species.

Charr *Salvelinus;* one species.

Whitefish *Prosopium* (Coregonus); Truckee River and Lake Tahoe basins.

Introduced Species

Trout and Atlantic Salmon *Salmo;* several species.
Great Lake Trout; *Cristivomer.*
Brook Trout; *Salvelinus.*
Montana Grayling; *Thymallus.*

NATIVE TROUTS

The difficulty of separating and defining the various species or races of western trout has long been recognized. The problem does not essentially differ however from that presented by the chipmunks or song sparrows, or even the native aborigines. In their entirety they seem to form a huge mosaic, the elements of which, as diverse as the golden trout of the High Sierra, the coast rainbow and the royal silver trout of Lake Tahoe, are difficult to separate. The picture includes not only the colors of the entire spectrum, but numerous irregularities of form, anatomical structure and habits as well. These trout present a veritable medley of geographic races or forms that make logical treatment very difficult. Attempts at systematic investigation have been made and some generally accepted species have been recognized. These attempts have been sporadic in all cases; they have been founded upon insufficient material, and they have not contributed greatly to a reasonable interpretation of the situation as a whole. The problem may now be impossible of satisfactory treatment because of depletion or near extermination of certain forms of restricted distribution and of the activities of artificial propagation in the distribution of various trouts.

Real contributions to the speciation of trout will not come from cursory inspections of occasional fish from here or there, but rather from careful studies of large series of examples from single localities.

California trout, as also the stories relating to them, sometimes grow to enormous size. There are many records of over 20 pounds for both rainbows and cutthroats; 14,578 steelheads were once taken in Klamath River from August 5 to September 6. On some days these fish, large and small, averaged as little as 3.2 pounds or as large as 6.7 pounds. The average weight of the entire number was 5.7 pounds. In the winter migration the fish are much larger, examples frequently weighing 12 to 28 pounds according to sober and competent observers.

It takes several years for a trout to attain a weight of 5 or 6 pounds, longer than for a deer to reach a legal size for the hunter. Yet the day limit on trout carries less restriction than the year limit on deer and the open season on trout is very much longer. Unless pre-

cautions are taken it seems evident that some of our native trouts like our wild flowers will disappear, giving place to various exotic weeds and mongrel crosses.

The following species of native trout have been generally recognized:

Rainbow Series, pages 102–108

Coast Rainbow Trout *Salmo irideus.* All streams entering the ocean.

Shasta Trout *Salmo stonei.* Upper Sacramento and McCloud rivers. The rainbow trout of fish culture fame.

Kern River Trout *Salmo gilberti.* Kern River and possibly other streams draining the southern Sierras.

Volcano Creek Golden Trout *Salmo roosevelti.* Volcano Creek.

Soda Creek Golden Trout *Salmo whitei.* Upper Kern tributaries, Soda Creek, Wet Meadow Creek, Coyote Creek and Little Kern River.

South Fork Golden Trout *Salmo agua-bonita.* South Fork of Kern River.

Culver Lake Trout *Salmo rosei.* Lake Culver and neighboring lakes of the High Sierras.

San Gorgonio Trout *Salmo evermanni.* San Bernardino Mountains.

Eagle Lake Trout *Salmo aguilarum.* Eagle Lake.

Royal Silver Trout *Salmo regalis.* Lake Tahoe.

Cutthroat Series, pages 108–111

Coast Cutthroat Trout *Salmo clarki.* Coastal streams south to Mad River.

Tahoe Cutthroat Trout *Salmo henshawi.* Lake Tahoe and Truckee basin, Walker and Owens River.

Colorado River Trout *Salmo pleuriticus.* Salton Sea, New River.

The Charrs, page 111 et seq.

Dolly Varden Trout *Salvelinus spectabilis.* Upper tributaries of Sacramento River.

INTRODUCED SPECIES

A considerable number of exotic fishes have been introduced into the State. Some of these appear to occupy niches not so well adapted to native species where they thrive and furnish sport fishing. Others are of questioned value and some are recognized nuisances.

The distribution of introduced species should be guarded with great care and so controlled as not to displace or endanger the native trout. The introduction of foreign animals is usually attended with danger and sometimes with disastrous results. Its practice usually comes from a too prevalent human desire to tinker and meddle with nature. In many cases it accompanies an inability or an unwillingness to conserve native fishes which in some instances are markedly superior.

Introduced trout and trout-like forms are—pages 111–112.

Loch Leven Trout *Salmo levenensis* early crossed with importations of Brown Trout *Salmo fario* of Europe.

Brook Trout *Salvelinus fontinalis*, a charr native of Atlantic coast streams.

Mackinaw Trout *Cristivomer namaycush* from the lakes of northeastern United States.

Montana Grayling *Thymallus montanus*, which now appears to be established in the Yosemite region. When compared with trout the grayling is immediately distinguished by its large and highly colored dorsal fin. The mouth is smaller and the body more slender. The eggs are more delicate than those of trout. The grayling is a gamey fish and not so wary as the trout. It is sub-arctic in distribution, adapted only to our high mountain waters.

Atlantic Salmon *Salmo sebago*. Attempts have been made from time to time to introduce this fish but without apparent success. Lately large introductions have been made in Smith River. This species will not as popularly supposed replace western salmon, *Oncorhynchus* where they have become depleted but will, if established, become a competitor of our native steelhead.

THE CUTTHROATS AND THE RAINBOWS

In the opinion of the writer, all the native trouts of California (excepting the charrs) belong to two groups or great races, namely the cutthroats and the rainbows. The cutthroats are the more boreal or alpine, while the rainbows are the more austral, and more generally distributed. The cutthroats are characterized by having smaller scales, a somewhat more complete dentition, more numerous black spots, and usually a red streak beneath the mandible, from the presence of which their name is derived.

The cutthroat is found in the coastal streams from the Oregon border southward to Redwood Creek, or possibly Mad River. It has been reported from Eel River, but no examples have come to hand in support of the record. It occurs in the eastern drainage of the Sierras (Truckee and Walker basins, and in Owens River), and in the Colorado River from which it gained a temporary access to Salton Sea.

The rainbows are pretty generally distributed in the trout waters of the State, in some places living as natives with the cutthroats. Rainbows inhabiting the upper courses of the mountain streams have finer scales than those of the coastal region, thus exhibiting a well known boreal characteristic.

By adherence to the assumption that all California trouts may be assembled in two natural groups, cutthroats and rainbows, one is enabled to account for their derivation and relationships as well as their present geographic distribution in a fairly logical way.

THE STEELHEADS

Some observers hold to the belief that the steelhead is a distinct species of trout somewhat intermediate between the cutthroat and the rainbow. Such is not the case, and this statement is supported by a mass of observational and experimental evidence. A steelhead is a sea migrant of the particular species inhabiting the stream, and in our waters it may be either a cutthroat steelhead or a rainbow steelhead. There is no occasion to apply a Linnean binomial name to a steelhead as such, and therefore the name *Salmo gairdneri* of Richardson and more recent authors should be omitted from our lists.

The steelhead is a fish that has come from the sea and entered a river to spawn. The resulting young live in the stream for from one to three years as rainbow or cutthroat trout and then migrate to the ocean. Some individuals appear to remain in fresh water during life. Steelheads come in from the sea in regular migrations which occur at more or less definite times. The migration is so timed as to provide for the arrival of the fish on the spawning beds when conditions are best fitted for propagation. For example, a migration of such fish appears in the estuary of Klamath River during the fall and early winter. The fish of this migration have in general a long distance to travel. Their entry into the river and their progress up stream are apparently coordinated with conditions in the tributaries. They enter Shasta River where their migration is in full swing, long before they appear in Beaver Creek the mouth of which these advance migrants have already passed. The smaller coastal streams are not visited so early, some of them being temporarily closed by bars, while others although open do not have a sufficient flow of water. A migration is not a steady movement of fish. It has a general rise and decline, but it has periodical irregularities as well, waves of varying intensity so to speak, the cause of which is problematical.

As the steelheads appear fresh from the ocean they are a beautiful steel blue above with bright, silvery sides. They usually have very definite black spots on the head and body (those of the head round, of the body linear), and on the unpaired fins. Sometimes the head is without apparent spots and the body has relatively few. The ova found in the early migrants are very small, their relatively undeveloped condition giving rise to the conjecture that these fish have entered upon a very long migration, or at least a considerable sojourn in fresh water, and this has been found to be true. Later migrants usually have more mature ova, as their spawning time is less remote.

On entering the streams their stomachs are usually empty, and they seem to remain so while they are in the estuaries. A little farther up stream their appetites appear to return, and their behavior is governed accordingly. They snap a fly or a spoon with avidity, and in rapid water they severely test the angler's skill. It appears, however, that the activities of stream life are largely supported by stored energy which has been accumulated in the sea. They enter the stream robust and corpulent, overloaded with vigor, and they leave relatively wan and emaciated.

Steelheads enter all the coastal streams which are large enough, sometimes appearing where the volume of water is scarcely sufficient to carry them. When fresh from the sea, resplendent in their blues and bright silver, the steelheads may often be seen in numbers leaping high from the surface of the water and falling with a great splash. They seem fairly intoxicated from their new experience in the stream. Their colors begin to change. The linear spots grow larger and more nearly round while others appear in regions where they seemed absent. As time passes and they progress up stream they assume the bright hues of stream trout and all degrees of coloration may be found among them from the typical steelhead to that of a brilliant rainbow. Sometimes belated steelheads progress so rapidly as to be found near the headwaters still bearing much of their marine color and mingling with

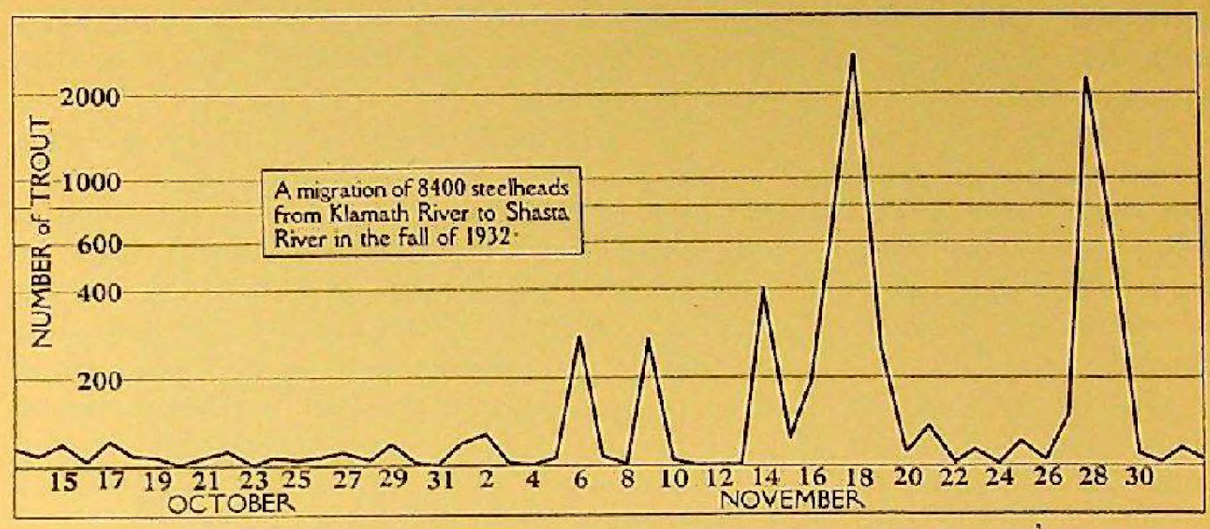
NUMBER of TROUT
2000
1000
600
400
200
A migration of 8400 steelheads from Klamath River to Shasta River in the fall of 1932
15 17 19 21 23 25 27 29 31 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
OCTOBER
NOVEMBER

Fig. 21.

more brightly tinted trout already arrayed in their nuptial hues. Steelheads all come to the fresh water to spawn, and unless prevented most of them will accomplish their purpose and eventually return to the sea. Some die, perhaps from injury, old age, or from the unusual exertion incident to migration. A few remain for an indefinite time in fresh water. In many of the larger streams with constantly open communication with the sea, are trout of considerable size and scarcely if at all distinguishable from the spawning steelheads. These fish appear to be residents of the river.

Lake rainbows behave as do ocean steelheads, migrating from the deep water to spawn in the streams. The cutthroat of Pyramid Lake, Nevada, furnishes an exact parallel with the ocean steelhead in that its lake colors are largely silvery and pale olive, while in the river on its spawning migration it assumes a wonderful dress of red and gold.

The cutthroat steelheads of the coastal streams perform only short migrations up stream, leaving the real mountain climbing to the rainbows.

Steelheads are sometimes caught by fishermen at sea, far from the mouths of any rivers. When so taken they look exactly like fish which have just entered the river.

Steelheads bear a superficial resemblance to salmon, four species of which migrate into our streams to spawn. Salmon all die after spawning and in this they differ greatly from steelheads. There is no occasion to confuse steelheads and salmon if one observes closely. While they differ in many anatomical particulars, the trout, large or small may be known by the shorter anal base (rays usually 12 or fewer, compared with 13 to 16 or more in the salmon), the deeper caudal peduncle, the narrower anal fin, and the white lining of the mouth. A salmon's mouth has much black inside. The color of the flesh is not of interest in this connection, as an occasional steelhead or trout has very red flesh, while some salmon may be pink or almost white.

The determination of the specific status of the steelhead is an important step in the direction of conservation, for it now becomes evident that protection for the steelhead involves both the rainbow and cutthroat trouts. Overfishing of stream trout depletes the steelhead and destruction of the steelhead removes the breeding stock of the stream trout.

During the summer and fall the steelhead streams which are not greatly depleted are amply stocked with robust and vigorous little fish, the result of natural propagation. These are nicely and equally distributed throughout the well aerated, food producing tributaries. If these were well protected and allowed to migrate to the sea, a supply of returning steelheads would be assured. It is the writer's opinion that the introduction of artificially propagated fish in such situations upsets the balance and serves no good purpose. He further believes that ample protection of nursery tributaries, or what amounts to the same, an enforced size limit of 10 inches or so, would insure steelhead fishing in the northern coastal streams for many years to come.

THE SCALES OF TROUT

Contrary to the expressed belief of some anglers, all trout have scales. They first appear as little rings or plates when the fish measure an inch or so in length, and their size increases nearly in proportion to that of the fish. In some cases, particularly when the trout approaches the spawning period, the skin thickens and the minute pouches which hold the scales tend to enclose them, and they seem to disappear.

The scales are very thin, flexible things and almost perfectly transparent. They grow by the addition of circular plates, and when examined under a lens appear much like the cut end of a twig in that they present growth rings. Like the twig they also exhibit annular regions which correspond to periods of inactive growth. Growth rings are illustrated by figure 23, which was made from the scale of an Eel River steelhead. The areas of arrested growth are evident at points 1 and 2. The fish had spent one year or so at sea and returned on a stream migration. Locally it is called a "half pounder." This particular fish had lived two seasons in the stream, and the growth of that period is shown on the scale from the center out to the point 2. The more rapid ocean growth appears beyond that point. In the streams the fish grow three to six inches or even more in a year. In two years

Fig. 22. A scale from a small Eel River steelhead which, having spent two years in the river and one in the ocean, has just returned on its first spawning migration.

they may measure eight inches or more. M, N and O of figure 24 represents scales of stream trout of different ages.

The unusual activities attending migration and spawning together with the rapid development of eggs and milt not only arrest bodily growth at the time but also cause such a heavy draft upon some of the tissues as to partly break them down. This condition becomes a matter of record in the scales, and leaves what is commonly called a spawning scar, visible at A and D in figure 25. This figure presents a fish that had migrated from the stream into the ocean in its third year of growth. It had successfully spawned two times as indicated by the scars, and returned again in its fifth or sixth year. This fish measured 25½ inches and was caught in Klamath River.

An examination of some Klamath steelheads reveals age, growth and spawning records as follows:

Stream	*Ocean*	*Spawned*	*Age*	*Length*
1 year	2 years	0 times	3 years	270 mm.
3 years	3 years	2 times	6 years	645 mm.
1 year	4 years	2 times	5 years	625 mm.
2 years	3 years	2 times	5 years	635 mm.
3 years	4 years	3 times	7 years	640 mm.
2 years	2 years	1 time	4 years	480 mm.
3 years	2 years	1 time	5 years	530 mm.
2 years	3 years	1 time	5 years	635 mm.
2 years	2 years	0 times	4 years	370 mm.
3 years	1 year	0 times	4 years	345 mm.

There is here a possibility of learning much of the life of a trout, as we are able to read the more or less accurate record preserved in the scales.

Fig. 23. Photomicrograph of the scales of three stream trout, the first being one year old, the second two, the third has entered upon the third year of growth.

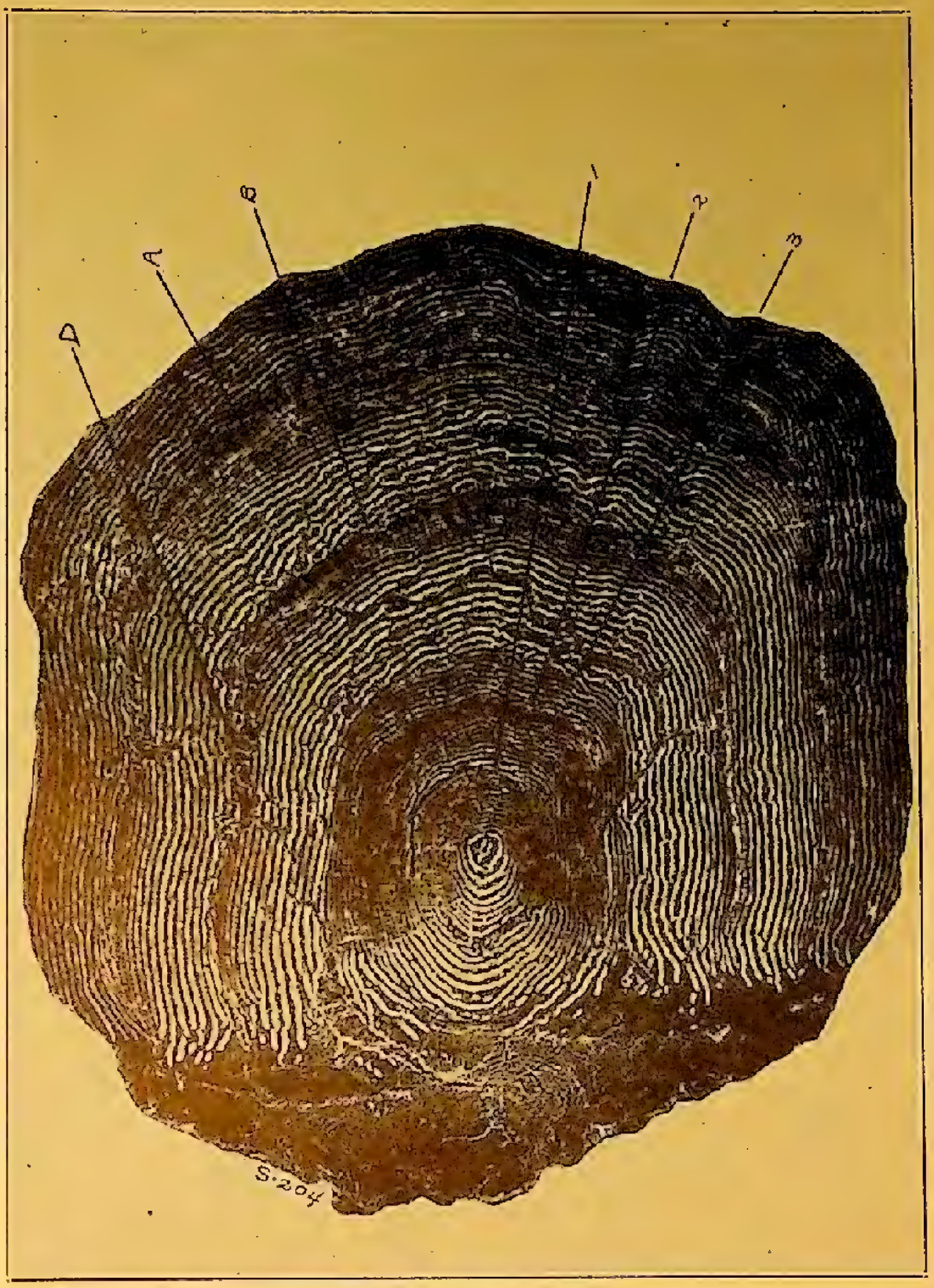

Fig. 21. A scale of a Klamath River steelhead with a three-year stream record. The fish returned to the river a third time after having successfully accomplished two previous spawning migrations.

SPECIAL SENSES

There is little doubt that trout possess some of the special senses developed to a considerable degree of perfection. Sight is evident, but the degree of selective vision is in doubt. In inspecting an object on or above the surface the fish is at a disadvantage for its vision is directed through a surface film and against a strong light. Movement, whether of objects or their shadows is quickly detected. Changes of bodily color are controlled to some extent through vision. Blind trout are very dark in contrast with the much lighter normal fish in a school. Hearing is limited, for there is neither tympanum or external ear. Vibrations produced by a footfall or crunching gravel are recognized. Taste and smell are closely associated, but it seems evident that food in the water may be detected by some means other than vision.

Trout are fish of simple habits, possessing none of the finer instincts such as parental care for the young.

COLOR

Adult trout, particularly those approaching the spawning season exhibit a varied and brilliant display of color. Young trout in common with most salmonids are relatively plain except for parr marks along the sides. There are as many as 10 or 12 of these in some species, fewer in others. They sometimes persist 2 or 3 years, occasionally remaining in adults. These particular marks may be regarded as a heritage from some primitive ancestor of the various salmons and trouts.

If, with a lens, one inspects the bright lateral stripe of a trout, the color whether black or red is seen to break up into minute specks. A greater magnification will resolve these specks into peculiar black and orange objects known as melanophores and xanthophores. They remind one of splotches of ink. A little further search brings out other elements which are involved in the production of color, and persistent investigation reveals a wonderful variety of chromatophores, pigment granules, and guanin crystals, together with a remarkable and little understood nerve control.

FOOD OF TROUT

Trout are carnivorous feeders and when considered at large they appear to eat anything that moves and some things that do not. The most delicate and ephemeral insects attract them to the surface at times, while at others they will swallow bottom larvae, stone or stick covered cases and all. They will eat the eggs and young of other fishes or of their own kind. They occasionally gorge until the food projects from their mouths and again they are able to fast for considerable periods without being much the worse for it.

In studying the food of trout it is preferable to use net caught fish, thus avoiding a selection of hungry individuals. The stomachs should be opened at once and preserved before post-mortem digestion alters the contents.

In so far as we know at present, California waters, with the exception of high, alpine, granitic lakes, are abundantly supplied with natural food, and the stream growth of trout and other fishes is fairly rapid.

It is thought by many anglers, and apparently with good reason that trout are very careful in their selection of insect food, and with

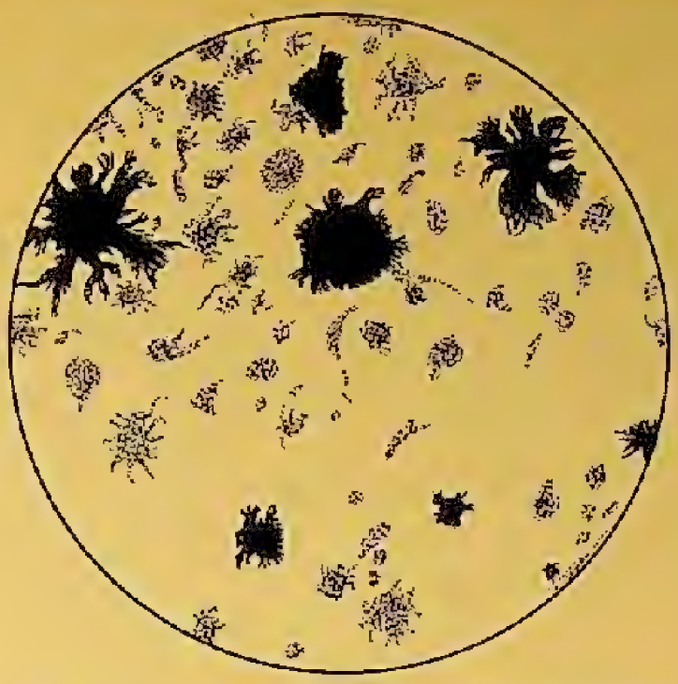

Fig. 25. A bit of epidermis, highly magnified to illustrate color pigment. The black spots are known as melanophores; the gray ones (orange in life) are xanthophores.

this in mind a large number and variety of artificial lures have been constructed. Some of these resemble real insects with the greatest nicety, while others are admittedly monstrosities. They are often ingeniously made and very beautiful.

Of late years there has been a disposition on the part of experimental investigators to uncover facts which seem to discredit the age old belief in the fine visual discrimination possessed by trout. Possibly the activities of such investigators should be curbed before they succeed in dispelling too much of the glamour attending these remarkable fish. It will be some time however before this approaching cloud comes to obscure the entire sky. In the meantime the royal coachman, the pale evening dun, the black gnat, and what not will serve to decorate the flybook, while the occasional skeptic maintains that it is not so much what fly you fish as how you fish it.

Fig. 26. An ephemeral insect.

BARRIERS TO MIGRATION

In their various migrations trout are occasionally confronted with artificial barriers which either impede or check their progress, or with diversions which lead them to certain death. River pollution or an impassable dam may create new conditions under which fish must either live or disappear. Conservation and propagation should take account of them.

Migratory fish are usually assisted in passing most dams by means of fishways. These embrace pools and little falls, gradually leading from the stream up and over the obstruction. They take advantage of the climbing instinct of the fish, the falling water indicating direction while the pool offers a resting place and room for the necessary start on another leap. The location and building of a successful fishway involve a knowledge of migrating fish and considerable engineering skill as well.

Diversions, usually caused by irrigation or the use of water for power, should be guarded by screens or deflections which prevent the

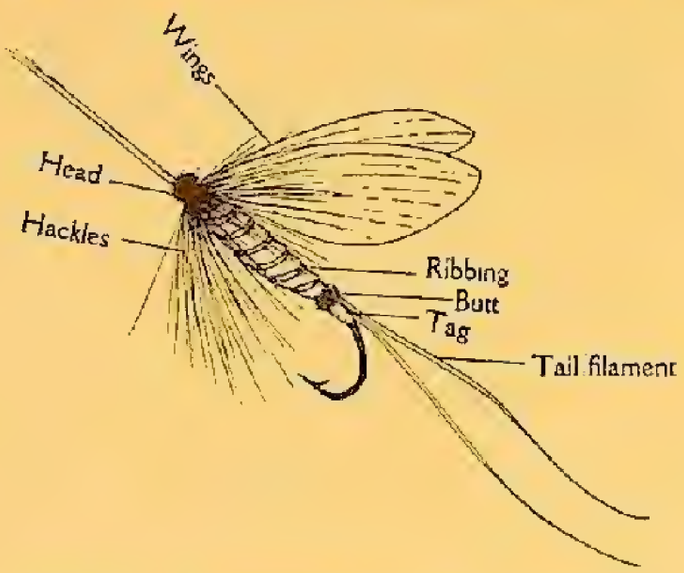

Fig. 27. An artificial fly which simulates an ephemeral insect.

passage of fish and hold them to the desired channel. These are of various types, some being so arranged as to revolve in a manner to carry over and dispose of floating debris.

The presence of barriers and diversions is no doubt responsible in a large measure for the depletion of trout and salmon. Protective laws and much firmness and diplomacy in their administration seem necessary if serious losses are to be prevented.

ARTIFICIAL PROPAGATION AND DISTRIBUTION

Artificial propagation of trout consists in securing and fertilizing the eggs and rearing the resulting fry and fingerlings until ready for introduction into suitable streams and lakes. At all stages it requires the skill of experienced men, and it is fraught with many difficulties. It is an interesting occupation which appeals to a particular type of man, as all who have inspected a well administered hatchery with its wonderful exhibit of developing eggs and growing fish will agree. Here under our eyes many secrets which nature had very carefully hidden in

the tumbling and foaming waters of our mountain streams are brought to light.

Artificial propagation should supplement rather than supplant natural propagation. At its best it is self sustained, depending upon brood fish for its eggs, thus taking nothing from the natural propagation of the streams. It accomplishes much when properly directed. It adds to the stock of depleted waters and it introduces fishes where none was found in nature. It should not, however, be charged with the entire responsibility of maintaining an unlimited supply of fish against an uncurbed and irresponsible demand.

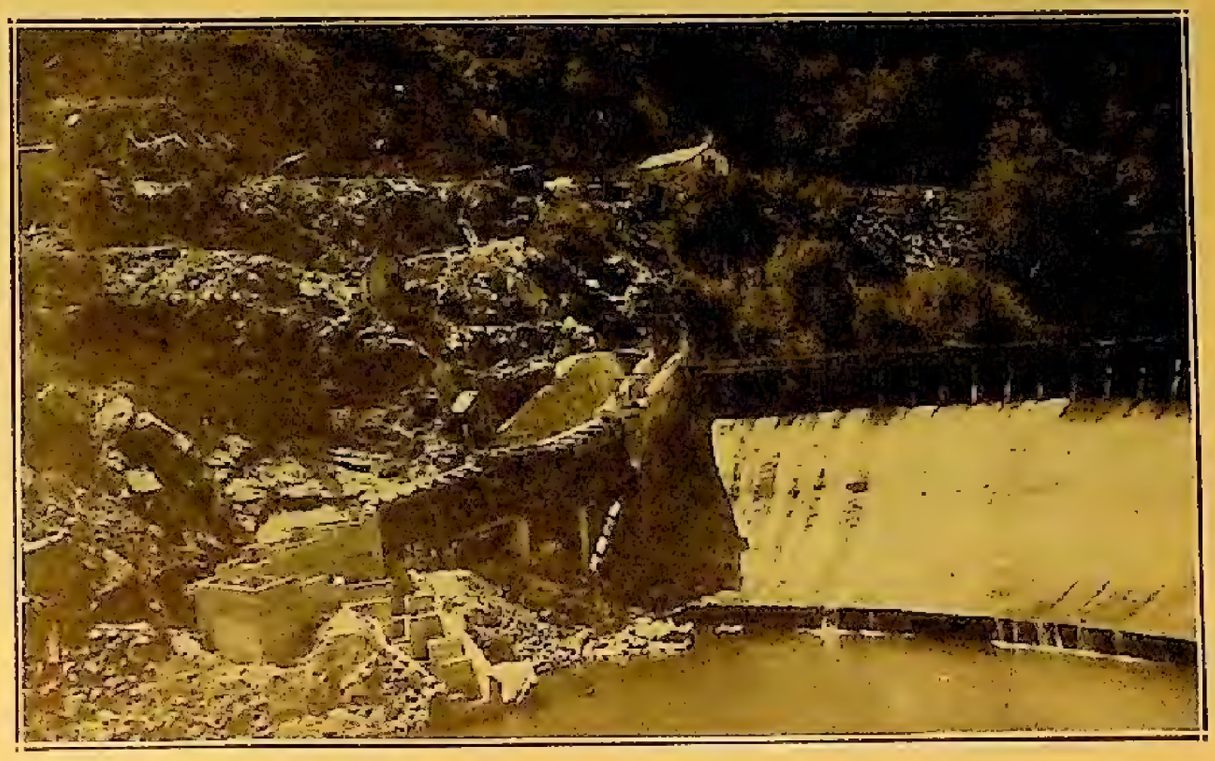

Fig. 28. A fishway for a dam 45 feet in height. Located on the North Fork of the Feather River. Photograph by J. Spencer.

One of the greatest foes of artificial propagation is disease. The losses from its inroads have never been carefully measured but on every hand they are admitted to be serious. In the streams and lakes, trout are practically free from serious disease, but like humans, when the population becomes unduly crowded trouble arises. In most cases diseases in the hatcheries are due to protozoans (minute animals), worms, small crustaceans, fungus, and bacteria. If properly diagnosed and treated the ravages of fish disease may be checked. Hygienic methods may prevent its appearance. The Bureau of Fish Culture has lately added an agency for the scientific study and control of trout diseases and much is expected from it.

The State maintains a large number of hatcheries and egg-taking stations, and some of these as Mount Shasta, Yosemite and Forest Home, are annually visited by thousands of people. They produce millions of fingerlings and larger fish which are carefully distributed and planted in an effort to substantially contribute to the sport of angling.

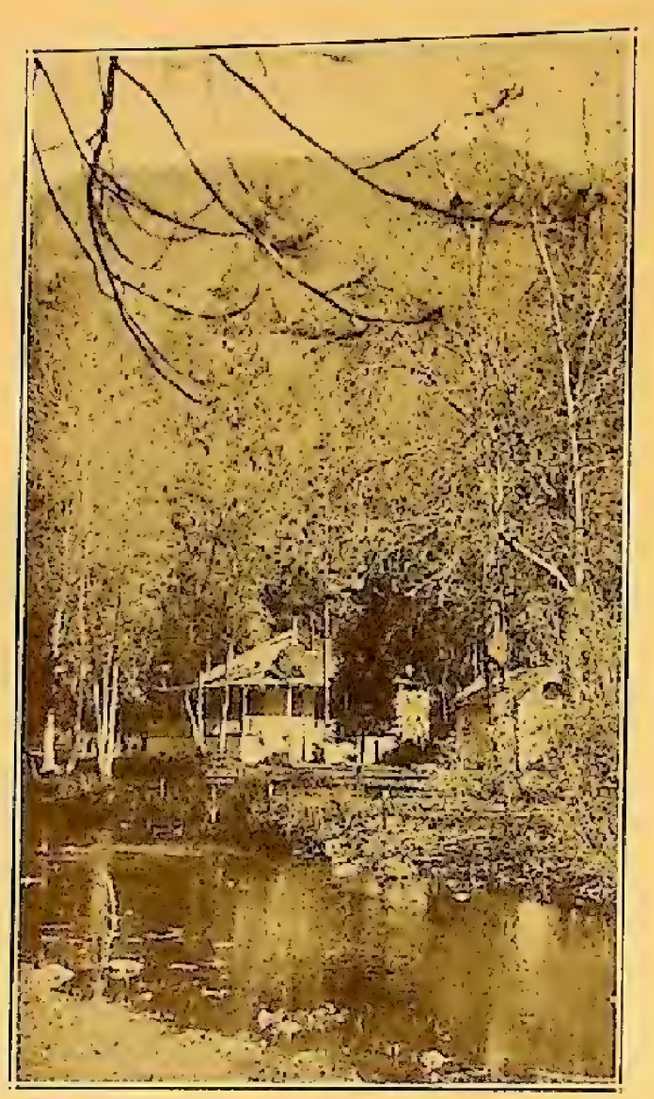

Fig. 29. A hatcheryman's cottage in the mountains.

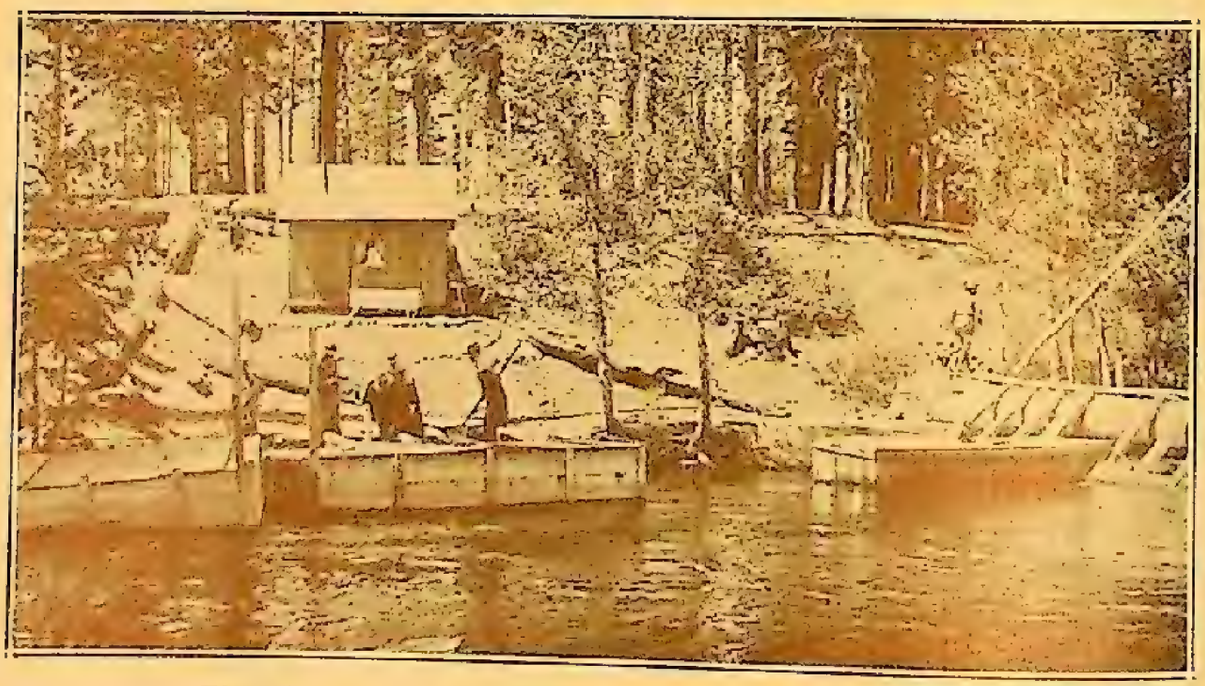

Fig. 30. A station where eggs are taken from wild fish.

The distribution of fingerlings, little fish produced by the hatcheries, usually begins in May, but July, August and September are the months of greatest activity. The early plantings often result from the necessary easements where fish become crowded, and these should be made in the headwaters where the native fish are small. Larger fish are available as growth is attained and these are introduced as the spring freshets subside or the snow retreats in the mountains. In some localities many fish of large size are distributed.

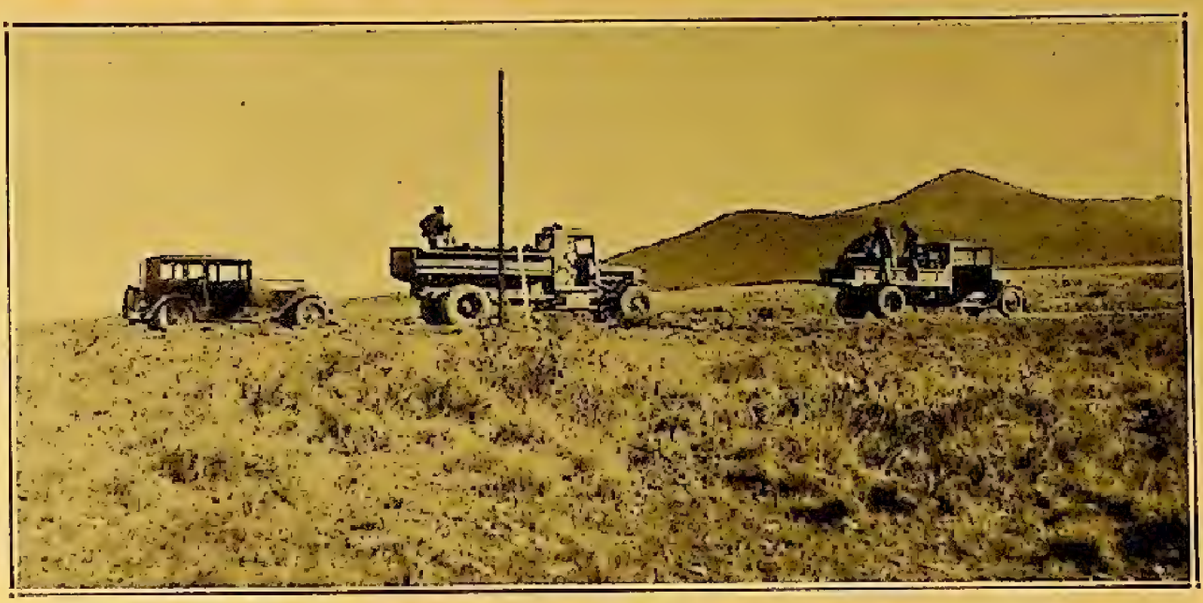

Fig. 31. A halt for the examination of trout in the course of transportation.

The cost of rearing and distributing large fish is considerable and one may arrive at some notion of it when he considers that it takes about five pounds of animal food to produce one pound of small fish. Of five-inch fish there are about sixteen or seventeen in a pound, while of nine to eleven-inch fish there will only be two or three in a pound. To the expense of food must be added that of labor and distribution. The cost of distribution rises very rapidly with increased size of fish.

Distribution is carried on by means of railroad cars, especially fitted for the purpose, trucks, pack-horses, and in some cases the cans are carried on the backs of men. A great deal is invested in the necessary equipment for distribution, but its successful operation depends largely upon the friendly cooperation of the railroads, sportsmen's organizations and other groups of willing people.

ROUGH FISH AND THE TROUT

Through the ages the native trout have lived, multiplied, and held their own in the presence of the so-called rough fish, minnows, suckers, sculpins, and others. Some western minnows, as the Sacramento pike and the hardhead, for example, grow to large size, and with growth become voracious like true carnivorous fishes. It may be that these minnows, permitted to increase, while the trout have become depleted, are correspondingly more dangerous. The suckers are not known to interfere with trout. Sculpins eat both eggs and small fish, but they

are fortunately not abundant. The most destructive and despicable rough fish is the introduced carp. Trout may have suffered as much from black bass as from any native fish.

Depletion of the trout has lately attracted attention to almost every possible cause except the increased activities of anglers. A great hue and cry has been directed toward the rough fish. Some of these may be very destructive in certain places, but there appears no direct or very convincing evidence against them. The entire matter of the ecological relations of these fish and the trout deserves careful investigation and if some species are found to be detrimental, then measures of control, which may take advantage of what is learned of their habits, should be devised.

Fig. 32. Pack train laden with golden trout at Muir Pass. Photograph by F. A. Bullard.

CONSERVATION

It is a matter of common observation of late years that trout are rapidly becoming less abundant in some quarters and literally disappearing in others. The causes of depletion or extermination are well known, but means of conservation and the reparation of losses are not so apparent.

Conservation of trout includes (1) the protection of young and adults at critical times and in exposed situations, from enemies, including man, and (2) artificial methods of propagation and distribution. Measures or means of conservation and their rational administration or application rest entirely upon what is learned from careful research. Research in this case includes the discovery of facts and a study of their interrelations. Sound measures of conservation can rest upon nothing else, and laws and regulations resulting from hearsay and guesses are futile. Conservation requires first of all a thorough knowledge of the situation and then a willing or enforced cooperation of all

concerned in carrying out such measures as have been devised. Many who have carefully considered conservation in its broadest sense have concluded that education of the public and especially of its younger members, should form an essential part of the program.

The people of this State are responsible for the conservation within its borders of some of the most remarkable and beautiful trout known to the world. They have created a particular agency, the Division of Fish and Game, and honored and trusted it with this responsibility. The future will hold it accountable.

Fig. 33. A catch of golden trout from Rock Creek near Lone Pine. Photograph by Burton Frasher.

THE SPORT OF TROUT FISHING

There is no sport that has developed greater refinement of apparatus or technique than that of trout fishing. Lures, leaders, lines, reels and rods have reached a degree of adaptability and perfection of beauty in construction and workmanship that is difficult to surpass. The materials of a good outfit are collected from the ends of the earth and when properly finished and fitted in the best proportion, they contribute to an ensemble that is well worthy of admiration. Part of the pleasure and enthusiasm of the angler centers about the fine and well kept tools of his sport.

There is no need here to direct the novice or to enlarge upon the outfit or the ways of the successful angler. Two or three popular books will offer ample food for thought, together with a sufficient vol-

mne of contradictory statements and lengthy arguments as to whether it is best to fish up or down stream, use wet or dry flies, tie your own or use the store product, select a tapered or a level line, a silver or copper spinner, or what not. Perhaps the most fortunate thing in relation to the suggestions of the various books is that the angler need not take them too seriously nor is he thereby forced to abandon his own initiative. The inquiring fisherman will meet with friendly suggestions on every hand. The supply houses are replete with tackle and information. Much of it is good, some of it indifferent or even bad. It is the privilege of the angler, and a part of the game to choose.

ANGLERS CONTRIBUTIONS

Anglers may offer substantial contributions to the ichthyology of trout. Their notes should take account of locality and date. Color descriptions should follow the nomenclature of external anatomy. The spots may be enumerated and localized by dividing the body into four parts by means of a vertical line through the anal opening across the lateral line. The size of the scales is expressed by counting the lateral series. Measurements should include the length from the tip of the snout to the base of the caudal, the depth at the deepest part of the

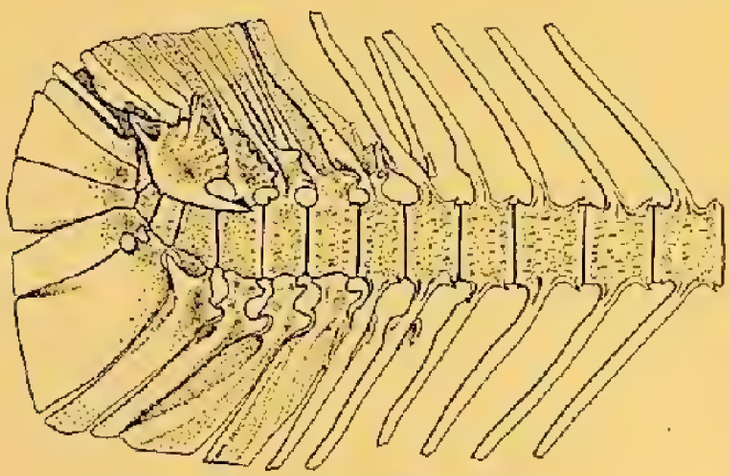

Fig. 34. A dissection of the tail with 13 vertebrae. The last two or three should not be overlooked in vertebral counts.

body, length of head and of maxillary, length or height of fins, especially the length of the caudal from its base to the tips of the middle rays. The skin of a trout may be removed and dried, thus preserving the scales and much of the color.

Scales for age determination should be removed from near the middle of the body. They should always be labeled with the species name, the length of the fish, the locality and date.

Vertebrae may be accurately counted after cooking the flesh in hot water and brushing and scraping it away. The last small and partly developed vertebra in the tail should be included.

The appended figures will aid in writing notes and interpreting descriptions.

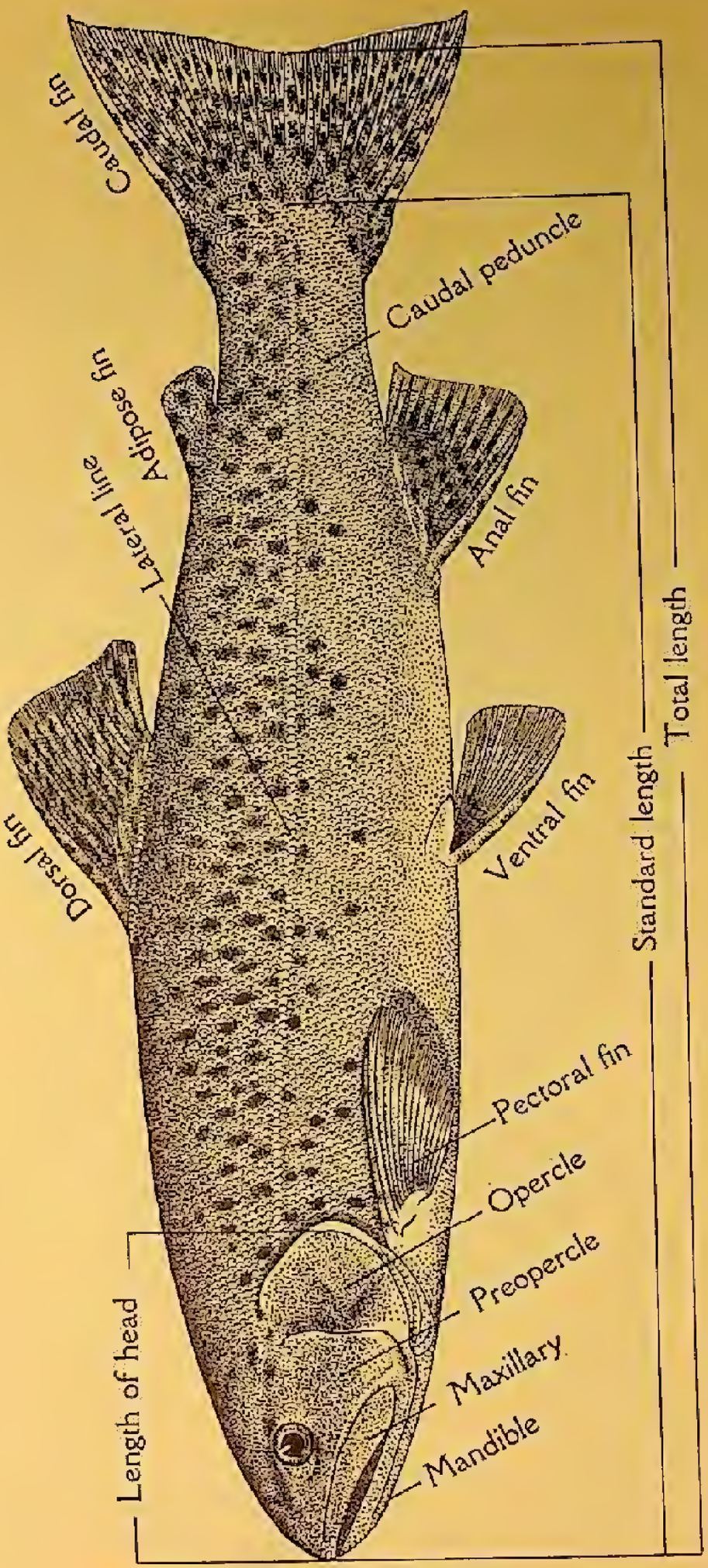

Fig. 35. Drawing of trout showing characteristics.

DESCRIPTIONS OF CALIFORNIA TROUT

As in the case of some peoples, American Indian and Asiatic Mongol for example, so with the trouts, cutthroat and rainbow alike, the distinguishing traits which separate them are difficult to set down in writing. Yet when one becomes familiar with them they may usually be recognized with certainty. The shape of the head and body, the dentition, the red throat mark, the squamation, the habits, etc., are not in each case always to be depended upon. Large acquaintance with them will demonstrate the futility of attempting an identification of their species by means of artificial keys or brief descriptions.

COAST RAINBOW TROUT

Salmo irideus Gibbons

Rainbow trout inhabit the coastal streams from the northern border of the State southward wherever the water is of sufficient volume to support them. Entering the streams as steelheads, they migrate to the uppermost tributaries, where they spawn and then return to the sea. The progeny of the steelheads remain for a time as stream trout drifting toward deeper water as they grow larger, some remaining three years or more before entering the ocean. In large bodies of water, lakes and river channels are resident trout which behave in their spawning migrations just as do the steelheads, seeking turbulent, well aerated water in which to deposit their eggs.

The coast rainbow trout or some of its near allies, has been extensively propagated by artificial means and widely distributed over the world. It is able to adapt itself to considerable ranges of temperature and a variety of natural conditions. It is generally conceded, that some of its brilliant color, its sprightliness, and its fighting spirit is lost when it is removed from its native waters. However, some anglers hold that introduction to foreign streams is attended with an improvement of these qualities.

The color forms are varied and individuals from one stream are apt to differ from those of another. A typical rainbow may resemble that presented in the color plate or it may be much darker or lighter, with the lateral color stripe broader or narrower, the fins lighter, pink or bronzy, the dark spots less numerous, larger and more rounded. In lakes or in silty water the spots contract or disappear and the general color becomes silvery.

The scales are large, the lateral series numbering 120 to 150 or so.

Growth varies with conditions. In the streams 4 or 5 inches are attained the first year and a length of 6 to 9 inches or more during the second. Examples measuring 9 or 10 inches or even more have been reported for the first year. In general a 9 or 10 inch fish is in its third year or it may be older.

An 18 to 22 inch fish may weigh $2\frac{3}{8}$ to $4\frac{1}{4}$ lbs.; a 24 to 28 inch fish, $5\frac{1}{2}$ to $9\frac{1}{4}$ lbs.; a 30 to 34 inch fish, 10 to 12 lbs. Rainbow trout weight much more than cutthroat trout of the same length.

COAST RAINBOW TROUT SALMO IRIDEUS GIBBONS

PLATE I

KERN RIVER TROUT SALMO GILBERTI JORDAN

PLATE II

SHASTA TROUT
Salmo stonei Jordan

The Shasta trout should be referred to as *Salmo stonei*, as it and *Salmo shasta* are synonymous, and *S. stonei* was first described. No specific characters can be found to distinguish between these two nominal forms.

The Shasta trout is described as a variant of the rainbow inhabiting the waters of the upper Sacramento and its tributary, the McCloud. It is distinguished by the smaller scales 150-165 in the lateral series, and by its color.

It is olivaceous above and paler below, with a brownish-red stripe. The opercles are washed with brownish-red. The under parts and the fins are yellowish. The tips of the dorsal, anal and ventrals are white.

Particular attention was early directed to the trout of the Sacramento and McCloud rivers because of its wide use in fish cultural operations and its popularity with sportsmen. It is difficult to find any anatomical characters to distinguish it from the rainbow of the coast. It has somewhat smaller scales, but it attains no larger size as has been said. One authority states that it has 63 vertebrae instead of 60 as in the case of the steelhead. Coast steelheads have from 60 to 63 or more vertebrae. A careful count of the vertebrae of 175 Klamath River steelheads stands as follows:

Number of Vertebrae	60	61	62	63	64	65
Number of examples	7	42	57	50	15	4

The curve or variation here exhibited is normal and it is typical of most specific characters which are capable of enumeration. A count of a like series of Shasta trout would probably show similar variation.

KERN RIVER TROUT
Salmo gilberti Jordan

As its name implies this form is limited to Kern River.

It resembles the coast rainbow in form and color as distinguished from the golden trout. It is profusely and closely spotted over the entire body and fins, a segregation of spots occurring on the caudal peduncle.

In life the dorsal surface is dark olivaceous or lighter and usually with fine yellow or orange specks. A broad, rich rosy band extends from the opercle to the anal base, the band growing wider toward the middle and somewhat darker posteriorly. Below the lateral band the body is strongly suffused with greenish-blue. The ventral surface of soiled white is washed with gold. The cheek and opercles are rosy, the head above is greenish-olive, the side of the jaw brownish. The dorsal and caudal are tinted with blue and olive, the pectorals, ventrals, and anal suffused with brown and pink, the tips of ventrals and anal white. The body and fins are closely spotted, the spots of the fins oval or elongate. The upper part of the head bears round spots, and there are a few similar spots scattered on the sides of the head.

Considerable variation in the number, size and shape of the spots appears, and the general brilliance of color differs among individuals.

SODA CREEK GOLDEN TROUT SALMO WHITEI EVERMANN

PLATE IV

SODA CREEK GOLDEN TROUT
Salmo whitei Evermann

The trout of Soda Creek, Coyote Creek, Wet Meadow Creek and Little Kern River were referred by the author of the species to *S. whitei*. It will be noted that of these streams, Coyote Creek is tributary to Kern River and is thus separated from the Little Kern basin.

The presence of small black spots on the top of the head and all but the lower one-third of the side is said to distinguish this from other species of golden trout. The described differences between this and *S. agua bonita* in so far as color is concerned appear to be slight. The scales of the latter appear to be larger, however.

In life the dorsal region of head and body is a light yellowish-olive, the color becoming lighter and assuming a light lemon tint on the lower sides. The ventral surface is reddish-orange between the throat and anal fin. A rather narrow orange-red lateral stripe extends from opercle to the base of caudal. Subocular area pinkish, cheek lemon, opercles orange. Dorsal fin light greenish-olive, tipped with yellow. Lower fins yellowish, the ventrals and anal tipped with white. Upper half of body and head, dorsal and caudal fins are abundantly provided with round and oval black spots, all smaller than the pupil. A few spots appear on the opercle.

There are about 200 scales in the lateral series. They are minute, frail and well imbedded.

This trout is fully as handsome as *S. roosevelti*. The parr-marks are said to be always present, they are rather narrow and a series of intermediate small rounded ones are present in a line below.

It is said that the trout of Coyote Creek exhibit greater variation than those of other localities; also that trout localized in the stream because of falls show an appreciable amount of distinctive coloration.

SOUTH FORK GOLDEN TROUT
Salmo aqua-bonita Jordan

The South Fork of Kern River is the native habitat of this form. It, like some other species, has been successfully introduced elsewhere, notably Cottonwood Lakes and Cottonwood Creek.

This golden trout is resembled very closely by *S. whitei*, apparently differing in having somewhat larger scales, 165 to 180 lateral series.

It is brilliantly colored in life, light olivaceous on the upper parts of head and body. The sides have a somewhat distinct rosy lateral stripe, brightest in the middle. The ventral surface is bright orange-red. Cheeks golden, yellow anteriorly, coppery posteriorly. The dorsal and anal fins are spotted, the other fins immaculate. The head and body are well spotted down to the lateral line, the spots covering the caudal peduncle. The dorsal is tipped with orange-red, the ventrals and anal with white.

Individually, much variation in color is seen, the general type and plan persisting. Like the other golden trouts, the parr-marks seem to persist regardless of size excepting in large lake examples, where they have been introduced.

CULVER LAKE TROUT

Salmo rosei Jordan and McGregor

This species was described from trout taken in an unnamed lake, later called Culver Lake, in the High Sierras. The lake is tributary to the Big Arroyo, a stream flowing into Kern River. It lies north of Five Lake Basin at an altitude of near 10,500 feet.

It is a large-headed, stocky fish with relatively small, generally scattered spots. The maxillary is long, and the upper contour of the head is markedly concave.

Its relationships are said to be with the golden trout of the region. There is difference of opinion as to whether this is a native fish or one introduced through artificial stocking.

In life it is described as having roundish black spots on the back and along the sides above the lateral line, some of which are nearly as large as the pupil. The spots on the sides below the lateral line are dash-like and less distinct. Spots are almost entirely absent on the top of the head. The ventrals are slightly dusky, with some red. There is a rather conspicuous rosy band along the lateral line. A faint cutthroat streak occurs on inner edge of the mandible.

SAN GORGONIO TROUT

Salmo evermanni Jordan and Grinnell

The native trout of the upper Santa Ana River in the San Bernardino Mountains is referred to this species.

It is distinguished from the coast rainbow by the finer scales, and the large round spots which are scattered evenly over the upper part of the head and body. The head is large and long and the snout sharp.

The trout of this species are isolated from the rainbows of the lower courses of the river by high falls. Individuals may pass down stream, and they do at times, but no trout from below enters their domain above the falls.

The native waters of the San Gorgonio trout are not easy of access, and it is hoped that the species may be protected from overfishing and from the necessity of competing or hybridizing with introduced fishes.

The scales in the lateral series number 162 or so.

An exact count of all the spots on one side of the body in an example resulted in 82, and most of these were about the size of the pupil.

EAGLE LAKE TROUT

Salmo aquilarum Snyder

This species is indigenous to Eagle Lake and its tributary stream Pine Creek.

It is robust in form with a deep caudal peduncle and very large adipose fin. The rayed fins are large and strong.

In life the body above and down the sides nearly to the lateral line is a rich dark olive, each scale brassy and very conspicuous. The sides below the olive region and the ventral surface are deep coppery-red with bright metallic reflections. The sides of the head are cherry-red, very rich in color. A trace of red beneath the mandible; iris brassy. The pectorals are broadly and conspicuously edged with olive. The

color here described is of a male. The female is very different. It is light olive above where each scale is silvery with greenish reflections. The sides are lighter, the scales more green than those above, the ventral surface silvery, tinted with pink. A very distinct pale reddish stripe extends along the side of the body, mostly below the lateral line. The cheeks and opercles are red, the iris orange. The ventrals and anal are suffused with red and distinctly edged with the same. When in the water the males are easily distinguished as their sides appear a deep coppery-red and the cheeks are particularly brilliant. There are very few black spots on the head. The middle of the back from the occiput to the dorsal is without spots. The unpaired fins and the upper part of the body have large rounded or elongate spots.

The lateral series of scales numbers 136 to 140; scales above lateral line 29 to 32; anal rays 11.

The flesh of this trout is deep red, very firm and fatty, far superior to that of the Tahoe trout. A considerable number were seen in May during the spring migration of 1913. They were very uniform in size, measuring 18 inches or so in length.

The native trout of Eagle Lake leads a precarious existence. The only spawning and nursery stream is Pine Creek, a small tributary with a fitful flow. Often many spawning fish are cut off by low water before they return to the lake, and many young trout are destroyed in like manner. Formerly Indians, and later some of the white population, by building wiers and traps and arming themselves with spears, took a considerable toll from the migration.

The species is of particular interest, as closely allied to and scarcely distinct from the rainbows of the western slopes of the Sierras, it occurs in the Great Basin drainage. The other fishes of Eagle Lake, suckers and minnows, belong to the Lahontan fauna, while the Tahoe trout characteristic of the Lahontan region of the Great Basin is not found there. The royal silver trout, although a member of the rainbow group, does not appear to be closely related to the Eagle Lake trout.

According to report it is difficult or impossible to catch this trout in the lake.

ROYAL SILVER TROUT

Salmo regalis Snyder

This species is known only from a few examples caught in Lake Tahoe. There is every reason to believe that it is rare and not simply overlooked. Fishermen are apt to confuse silvery examples of the Tahoe trout with this fish, although when placed side by side, a glance serves to reveal the difference.

It is a small-headed fish with a short, rounded snout, a narrow, weak, maxillary scarcely extending beyond the orbit. The opercles and branchiostegals are thin and papery. The jaws are weak and the teeth small. The gillrakers number 19 to 21, small and pointed. The scales number 144 to 150 in the lateral series; they are very thin and not deeply imbedded. The fins are all thin and relatively frail, the pectorals and ventrals sharply pointed.

The royal silver trout is distinguished at once among all other California species by its unusual color, deep blue on the dorsal surface which in some lights is slightly shaded with olive, the blue extending

downward on the sides to about the sixth row of scales above the lateral line, where it gives place to the most brilliant or burnished silver. The silver sheen dulls toward the ventral surface, the abdomen, throat and chin being dead white. No dark spots appear except a few very small ones on the dorsal and caudal fins. No red or yellow color is to be seen anywhere except on the cheek, where it glows faintly through the silver.

The species appears to be related to the emerald trout, *S. smaragdus* of Pyramid Lake, a fish equally rare and possibly soon to disappear as one of the last relics of the ancient Lake Lahontan. Both are apparently of rainbow stock long separated from those fishes west of the Sierras.

It has been taken with both fly and spinner. Its capture furnishes a real surprise to the angler when a prodigious leap from the surface of the water in true rainbow fashion reveals a dash of blue and a shimmer of silver not generally associated with trout.

COAST CUTTHROAT TROUT
Salmo clarki Richardson

This trout is a native of the streams in a narrow coastal region extending from Redwood Creek northward. It has been recorded from Eel River, but examples from that stream have never come to the writer's notice. Considerable seineing there has not caught any young of the species.

During the migrations of some years the cutthroats appear to about equal the rainbows in number in Redwood Creek, while usually the rainbows are more numerous.

Small cutthroats may be taken in some of the tributaries of the lower part of Klamath River but no adults have as yet been recorded there in a winter migration. An occasional cutthroat steelhead makes its appearance among the late summer rainbow steelheads. These look like the latter in shape and color, and unless the scales are carefully observed they may pass as rainbows. They are then very rare however, one cutthroat among thousands of rainbows.

The scales in the lateral series number from about 160 to 200 or so. Between the lateral line and the back there are 34 to 39 or 40.

In the month of January or sometimes earlier the cutthroats come into Redwood Creek to spawn. They find their way up the tributaries, and those entering Prairie Creek seem to be particularly well colored. In seeming keeping with the dark redwood forest with its fern lined mossy banks, the fish are very sombre. Their backs and sides are suffused with deep olive. In some examples the lower sides are yellowish. There is generally present an indefinitely outlined purplish lateral stripe extending from the opercle to the caudal fin. The pectorals are tinged with yellow, and the ventrals with salmon-pink. The jaws and sides of the head are yellowish. The upper part of the opercle is yellowish or occasionally golden, the lower part sometimes purple. The red gash under the mandible is bright salmon or red, very conspicuous and always present. An occasional individual has a small rounded golden spot somewhere on the lower part of the body.

This particular characteristic, a coinlike golden spot, may be seen on an occasional brightly colored Tahoe cutthroat.

The black spots are large and pretty well scattered over the head and body. Actual counts show from 26 to 71 on the head; 322 to 577 on the body. All of the fins bear spots.

TAHOE CUTTHROAT TROUT

Salmo henshawi Gill and Jordan

The Tahoe trout is a mountain cutthroat indigenous to streams of interior drainage. It is to be caught in Lake Tahoe and other waters of the Truckee system and in Walker and Owens rivers. Whether it is native in the latter stream is questioned. Its distribution has been somewhat extended by artificial propagation.

This trout occupies a region of great diversity of natural conditions and it seems to respond accordingly. Its color varieties might offer an open and fertile field to the systematist prone to describe geographic forms.

Although spawning occurs in Lake Tahoe in April, examples in nuptial color may be seen even late in June. The males are then of a dark, yellowish-olive color, with a faint metallic sheen, the dark color being usually uniform from the back to the ventral surface. On the side is a broad pinkish stripe, indefinite in outline and about ten scales wide. It originates on the opercle and extends to the tail where it gradually fades out. Each scale included in this stripe, and also in a broad area above and below is narrowly edged with pale yellow. The sides of the head and a triangular spot above the axil of the pectoral are scarlet or yellowish-scarlet. The under surface of the lower jaw has two parallel stripes of bright red. Even the tongue is tipped with crimson. One or more small, coin-like, golden spots may occasionally be found on the head. The entire head and body together with the unpaired fins are marked with dense brownish-black spots, usually larger than the pupil and rounded oval in outline, widely spaced and fairly regular in distribution. The females are lighter in color, though preserving the same general pattern.

Frequently individuals, large in size, fat and in fine condition are taken in deep water. They are very silvery and the spots are narrow and elongate. They are locally known as silver trout, and check lists still recognize them as *Salmo tahoensis*, a proceeding entirely unwarranted.

The Tahoe trout is a comparatively slender fish with a rather long and pointed head. Examples 18 to 20 inches long will weigh from 1½ to 2½ lbs.; 24 to 28 inches, 3½ to 7½ lbs. The scales run from 153 to 163 in the lateral series and 29 to 38 above the lateral line. Gillrakers 23 to 25; branchiostegals 10 or 11; cæca 70 to 85.

The lake fish feed largely on minnows which occur abundantly and of several species. At times they consume insects which have fallen upon the surface or are brought out by the streams. They are not to be regarded as surface feeders, and as the summer season progresses they go to deeper water, following the minnows which in turn seem to follow the plankton.

When taken with light tackle the Tahoe trout puts up a strong fight, but not so spectacular as that of the rainbow. They are said to reach a weight of 20 or 30 lbs.

In former years trout were very abundant in Lake Tahoe, and a considerable colony of market fishermen flourished there. They and many sport fishermen were in the habit of trolling with a heavy line, 100 feet of six strand No. 27 copper wire closely twisted. To this was attached a sufficient amount of hand line as a protection against fouling. On the distal end of the line was an attraction spoon measuring about 4 inches, beyond which was a foot or two of wire or gut leader carrying a small spinner with single, double or triple hook, or a baited single hook of liberal size. With this contraption tons of trout were dragged out of the lake and later shipped to San Francisco, or the mines of Nevada.

Lake Tahoe trout migrate into the small tributary streams to spawn, where the resulting offspring spend a year or more as stream fish. Overfishing of the lake and constant whipping of the streams together with other causes of depletion have greatly reduced the population. If the nursery streams were properly protected a reasonable amount of good fishing might always be had in the lake.

COLORADO RIVER TROUT

Salmo pleuriticus Cope

The Colorado River trout has come into the State by way of overflow waters passing into Salton Sea. It has been variously reported as abundant or scarce, but no authentic information relating to it is at hand. It is improbable that it will thrive in the waters of the sea because of high temperatures, and it may not maintain itself for lack of spawning places.

The relationships of this species are to be traced to the trouts of the eastern slopes of the Rocky Mountains and the Great Basin including *Salmo henshawi* of Lake Tahoe and *S. utah* of the Bonneville system. Through these a relation may be seen with the cutthroats of the Columbia system.

This is described as a brightly colored form with a red lateral band and with red or orange fins. The spotting is variable, some examples having the body fairly covered while others have spots only posteriorly. The head is usually immaculate.

Salton Sea examples are said to be very light in color.

The scales are small, there being 185 to 190 or more lateral series.

DOLLY VARDEN TROUT

Salvelinus spectabilis (Girard)

In California this species is found only here and there in the upper tributaries of Sacramento River, especially the McCloud. It extends northward, growing more plentiful toward British Columbia and Alaska, and grading into *S. malma* if indeed it really differs from that species.

It may be regarded as a native western representative of the brook trout, which it resembles somewhat in size, color and form. It is however more slender, and the back and dorsal fin are without blackish vermiculations, markings and blotches.

Dolly Varden trout are not in favor with fish culturists because of their predatory habits.

In life the color is olive above, lighter or darker as the case may be, light olive or grayish or greenish on the sides and white beneath. The iris is brassy. The fins are light olive with a brassy metallic sheen. The anterior rays and membranes of the ventrals are orange, while the distal half of these rays is edged with dead white. The anterior two or three of the anal rays are orange, the lower anterior edge of fin white. The spots on the sides of the body are bright orange or dark yellow.

The Dolly Varden is a beautiful fish, perhaps a little slow for the impatient angler and not overly demonstrative when hooked.

EASTERN BROOK TROUT

Salvelinus fontinalis (Mitchill)

The eastern brook trout was early introduced into the State where it now thrives in the cold waters of the high mountains. It is extensively propagated and used to stock depleted or barren waters.

The mottled or marbled color pattern, red spots on the sides and the reddish lower fins broadly edged with white serve to distinguish this trout, or rather charr, from the black-spotted natives.

In life the head, dorsal part of the body, dorsal and caudal fins are variously spotted and vermiculated with dark olive or black. The sides are covered with yellowish, greenish and bright red spots which form the centers of grayish or greenish circular areas. The lower parts of the sides and the ventral region are reddish, sometimes very deep and brilliant in color. Lighter examples have the head and back grayish-green, mottled with dark green or olive-black. The red spots on the sides are surrounded with light greenish-brown or gray areas. The ventral surface is tinted with pink.

The parr-marks, eight or so in number, often persist in large fish.

The scales are very small and so deeply imbedded as to usually escape notice.

This species is abundant in the Tahoe region, the Sierran lakes and streams, and in scattered localities in mountainous regions. It exhibits great variation in color. It is wary and some skill is required in its capture.

It spawns from early in October to well into December. The eggs are very small when compared with those of native trout, and they are deposited in a nest-like cavity and covered with gravel.

MACKINAW TROUT

Cristivomer namaycush (Walbaum)

The Mackinaw or Great Lakes Trout was introduced into Lake Tahoe from where it spread to neighboring lakes in the same basin.

This trout may be known by its long, pointed head, very long and slender maxillary, narrow caudal peduncle, deeply emarginate caudal fin, and by the color.

In life the head is dark greenish or olive, reticulated or clouded with blackish. The body is greenish or olive above, lighter on the sides and soiled white below. The back and sides are covered with large round or variously elongate yellowish, greenish or pink tinted spots. The dorsal and anal fins are spotted or vermiculated. The paired fins

and the anal are immaculate, and tinted with light pink, yellow and green.

Much variation in color appears, some examples being darker than others, the vermiculation and spotting varying as do the tints and shades.

The scales are very small, there being 200 or so in the lateral series.

This species spawns in the lakes, where it occasionally reaches a weight of 15 or 20 pounds. It is not greatly esteemed by anglers as it is rather heavy and sluggish. It is an omnivorous feeder with a ravenous appetite. Its further distribution in the State is not to be encouraged.

LOCH LEVEN TROUT

Salmo levenensis Walker

The Loch Leven trout of Scotland and the brown trout of Europe *S. fario* were early introduced into the waters of this country. In the hands of fish culturists they were eventually cross bred to such an extent that perhaps now no clear strain of either remains. Characteristic of hybrids the fishes now held in breeding ponds exhibit a variety of color pattern, occasional individuals resembling one or the other of the parent stock, while many differ from either.

This fish is valued particularly because it spawns in the fall and affords a relatively large growth before the time of summer planting arrives, and also, it seems to thrive in certain situations not so well adapted to other forms. It is not always easy to catch and is therefore less likely to be fished out.

The back and sides are brown, olive-brown, greenish or grayish, lighter on the sides, and silvery or almost white beneath. The back is covered with dark spots, very black in some examples, while on the sides the spots are red, surrounded by a light ring of varying width.

THE CALIFORNIA TROUT INVESTIGATIONS

By P. R. NEEDHAM, Ph. D., Associate Aquatic Biologist, U. S. Bureau of Fisheries

SPORTSMEN OF CALIFORNIA need not be told that their golden State from the Siskiyous to the San Bernardinos and from the sea to the Sierras is a fisherman's Paradise. Nor is the fact a secret in the East. But all will welcome the efforts of the fishery officers of the State and Federal governments to improve and maintain the supply of game fish, still so abundant in many localities but showing distressing signs of impending depletion in others. Heeding the demands for "less time between bites," the California Division of Fish and Game has arranged with the U. S. Bureau of Fisheries for a cooperative investigation of trout fishing conditions throughout the State. The heavy drain upon our fish supplies by the present day army

Fig. 36. The Klamath River near Orleans, California.

of anglers necessitates the adoption of scientific methods of husbandry or management in which a rational policy of stocking overfished or unproductive waters is an important element. Intensive investigations for the development of such a system of fishery management were begun in July 1931, by a staff of four investigators with headquarters at Stanford University. Two of the investigators, A. C. Taft, Assistant Aquatic Biologist, and the writer are furnished by the Federal bureau while two assistants, Francis Sumner and Leo Shapovalov, were appointed to the work by the State. Expenses are shared jointly by both agencies, and much useful field equipment has been supplied from both sources.

These investigations are a direct outgrowth of recommendations made by the Klamath River Study Committee of the California State Chamber of Commerce with regard to the maintenance and development of sport fishing in the Klamath River Fish and Game District. This district was created in 1924 by the people of California in Initiative Measure No. 11 to preserve the recreational facilities of this region.

Since the fish cultural problems relating to the Klamath River and its tributaries are fundamentally the same as those found in many other sections of the State, it was decided that greater practical value would result if the investigations were conducted so as to include in their scope the principal trout fishing areas.

Fig. 37. Field laboratory on Waddell Creek, Santa Cruz County. This is furnished for the investigations through the kindness of Professor Theodore Hoover, of Stanford University.

For the purpose of developing a long time research program, Dr. H. S. Davis, who is in charge of aquicultural investigations for the U. S. Bureau of Fisheries, was sent to California in July of last year to make a preliminary survey of the State's fish cultural problems and to work with the officials of the California Division of Fish and Game in the formulation of a joint, cooperative program. Dr. Davis, in company with Mr. Taft and the writer, made this preliminary survey of

the State during July and August. Most of the hatcheries and many of the best fishing areas in the State were visited and conditions noted. On August 17, 1932, at a conference with the State Fish and Game officials in San Francisco a research program was adopted which offers a comprehensive plan of study to be followed over a period of years looking toward a solution of the more basic problems relating to the trout.

The program as it is now arranged provides for attacking the trout problems from two sides, viz., a study of the trout themselves and a study of the stream or environment in which they live. In order that a truly scientific stocking policy may be developed, many new facts must be ascertained with respect to each of these phases of the work. Several states have instituted stream surveys and have built up elaborate stocking policies based upon them. However, facts available from

Fig. 38. Waddell Creek lagoon in late summer showing sand bar completely covering mouth on ocean side.

the investigations carried on in other states would not apply, in many instances, to local stream conditions. It would seem more logical to develop a policy based upon facts as they are found in the streams of California. Until this is done it will not be possible to develop a rational policy for the multitude of different types of waters found here.

More specifically, with regard to trout, a few of the problems upon which we are working are as follows:

1. A study of the species and races of trout to obtain as complete information as possible on the life history, habits, and ecological requirements.

2. The extent of natural propagation and its contribution toward stream populations.

3. Mortality of fish of various sizes when planted into the streams from the hatcheries.

These, in brief, outline our main projects with regard to trout. The first item includes, of course, native as well as introduced species. In so far as practicable these studies will be carried on in streams selected for environmental work so that the two aspects of the problem may be studied simultaneously.

Fig. 39. Waddell Creek, near Santa Cruz, at low water in early fall.

The extent and efficiency of natural propagation are problems about which very little information is available. Present stocking policies largely fail to consider this factor. Two schools of thought are prevalent, one maintaining that artificial (hatchery) propagation accounts for the bulk of fish in streams, the other that were it not for natural propagation there would be very few trout left. Accurate information on this problem will be extremely difficult to procure, but it is hoped that over a period of years it may be possible to arrive at a true evaluation of this process.

The mortality which may reasonably be expected when planting fish of various sizes is particularly important. Information on this

problem should shed further light on the question as to whether or not it is better to plant many small fish in a given stream or fewer larger fish. In order to ascertain facts of this nature an experimental stream will be used in which trout of various ages will be planted in screened sections and the normal mortality determined over stated periods of time.

The streams or environment of trout must also be examined for other equally useful information. The dominant questions here are:

1. Food: its seasonal abundance and distribution in relation to varying stream conditions.

2. Shelter: amount and kinds present which offer (1) protection from predatory enemies; (2) protected spawning grounds of the right sort.

3. Dams, falls, irrigation ditches, and water wheels and their effect on fish migrations.

4. Chemical conditions: pollution, gases in solution, hydrogen-ion concentration, etc.

Food is the most important single condition about which much information must be had before it will be possible to determine how many fish of any given size can be planted per mile of stream and all find sufficient nourishment for growth and reproduction. Naturally it is desirable from the angler's point of view as well as the fish culturist's that the food resources of streams be utilized to maintain the greatest density of population consistent with normal growth. In order to do this we must know first of all the number of pounds of natural foods required to produce a pound of trout. Then knowing the amount of available foods per given area of stream bed that are obtainable from season to season, it will be possible to more nearly approach an ideal number of fish that any given section of stream will support in relation to its food supply. Physiologists are now working on the gross turnover of foods to flesh in trout, and in a short time we should have the necessary information with regard to the former point. We are rapidly compiling data on the latter and already have obtained many interesting data. In the coastal streams we have found bottom foods varying from over 10,000 pounds per acre in one stream to less than a hundred in another. In the Feather River above the town of Chester we found an average of 377 pounds of bottom foods per acre of riffle area. It has already been determined by the writer that the riffles are the larders of streams. Here the bulk of food is produced, and the figures given refer only to riffle areas. Pools are valuable for other than food and are about one-fifth as rich in foods as riffles. One of the accompanying photographs shows a bottom sample being taken in the Feather River. Unit collections from areas covering one square foot are taken by hand, the organisms sorted from the trash and weighed. Calculations from averages obtained from many such samples then give the amount of available food per acre in any section of stream studied. Samples taken seasonally show the average annual amounts available as fish food.

Having obtained sufficient data on the problems outlined above and from the areas in which the work is to be pursued, it will be possible to fit the evidence together and formulate a sound scientific stocking policy. It should be stated, however, that it will probably never be possible to find out with arithmetical exactness the number of trout living in any

Fig. 40. Taking a bottom sample in the Feather River above the town of Chester.

given stream, how many are removed by anglers, or the exact numbers supplied through natural spawning, for there are too many physical difficulties involved. However, if only approximately accurate data be obtained on these questions, it will be far better than the present hit or miss methods commonly used.

The State of California offers a great variety of extremely contrasting natural conditions. For the purpose of investigations and the development of a stocking policy the trout waters of the State may be divided in three regions as follows: (1) Southern region, (2) Coastal region, (3) Sierra region. The latter can be subdivided into two regions: (a) Lower Sierra region, the waters of which are best adapted to rainbow and brown trout, and (b) the high Sierra region containing waters best suited to golden and eastern brook trout.

Fig. 41. Blackwood Creek about three miles above Lake Tahoe in early summer.

A knowledge of conditions in the trout waters of these regions throughout the year is essential for the development of a scientific stocking policy. It is believed that this information can best be obtained by selecting one or more representative streams in each region for intensive study with less detailed studies on other streams in the same locality for comparison.

Southern California streams like the San Gabriel, Santa Ana, and the San Antonio in the summer time are small bubbling brooks, which in the spring due to melting snow are changed to raging torrents which scour the stream beds and destroy many of the game fish. Seasonal extremes in both volume and temperature are the rule rather than the exception. The building of flood control dams and the drain on the water by irrigation projects offer specialized problems peculiar to this

region. The present policy of the Division of Fish and Game of planting principally aged fish in these streams is contributing materially toward the maintenance of trout.

On the other hand, in the high Sierras and fed by perpetual ice and snow are many lakes and streams containing golden, rainbow, and eastern brook trout which offer a completely different set of problems. Most of these high altitude lakes and streams are inaccessible for eight months out of the year, the growing season is extremely short and for the most part fish planted in these areas must be "packed in" on horseback or by hand over precipitous, narrow trails. Next summer investigations are to be started in the Cottonwood Lakes region with especial reference to the golden trout of the high Sierras.

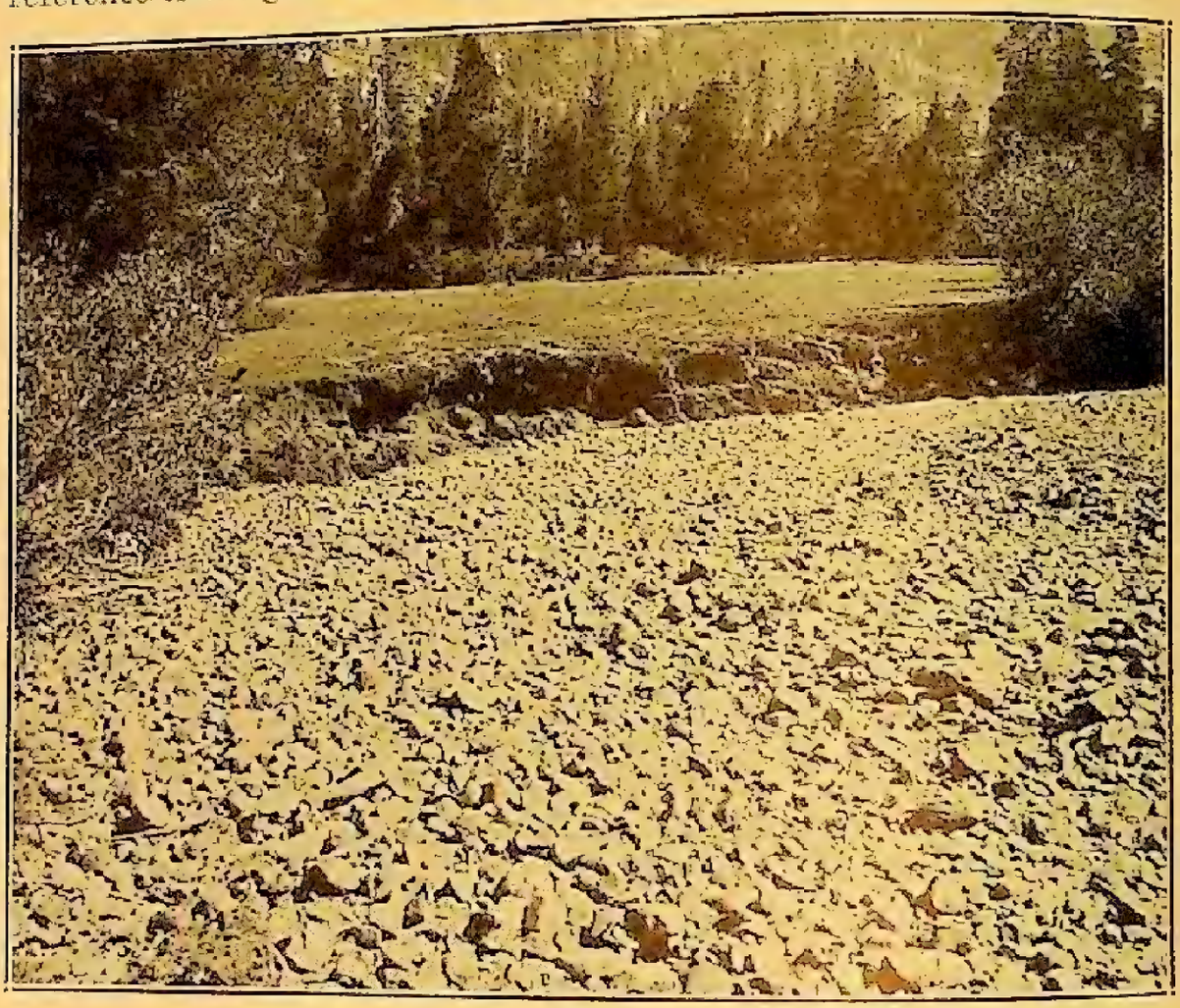

Fig. 42. Blackwood Creek, near the same point, in late summer. This section goes dry due to the water taking an underground course for about one mile. These pictures show one of the many contrasting conditions offering obstacles to the maintenance of fish life.

Also in what might be termed the lower Sierra region at considerably lower elevations are a fine series of big streams such as the Kern, Kings, San Joaquin, Tuolumne, Merced, American, and Feather rivers which offer other and different problems which must be studied. Some progress has already been made in a study of streams in this region with especial reference to the food supply. Taylor and Blackwood Creeks flowing into Lake Tahoe and the Lower Truckee River were investigated last fall and considerable information obtained. Next spring work is to be started in the Merced and Tuolumne rivers.

Keeping in mind the problems of the Klamath River as outlined by the Klamath River Study Committee, particular attention has been

given to the coastal steelhead streams of which the Klamath River is the largest and most important. All of these streams, large and small, have a basic similarity in the fact that they still have a considerable portion of the original run of fish that formerly inhabited them and which it is of paramount importance to maintain. These streams are at present largely self-supporting and in fact supply a considerable number of fish for stocking waters in the Sierras. Due to the fact that the steelhead spends a large part of its life in the ocean, where it is not accessible to anglers, it is better able to maintain itself than the fishes of the Sierra

Fig. 43. Fine steelheads taken in the Klamath River, near Hornbrook, California.

streams and lakes. Our work in the past year has been directed toward determining those facts in the life history of the steelhead which would be of value in retaining and increasing the supply of this fish.

Due to limited personnel and funds no comprehensive study of the Klamath is contemplated at this time, and instead most of the experimental work on coastal streams is being carried on in Alder Creek and Garcia River in Mendocino County, and in Scott and Waddell Creeks in Santa Cruz County. The results of work in these streams, at least in their broader aspects, will be applicable to all the coastal streams.

However, some study of the Klamath River as a separate entity is being conducted, and it is planned to expand this work as soon as means are available. Considerable data are already at hand from studies made early in November on the effect on the fish and stream foods of fluctuating water levels caused by the Copco power dam near the Oregon line.

Obviously it is physically impossible to investigate thoroughly all waters of the State, but it is believed that by selecting representative streams and lakes in each of the areas outlined, the information obtained will be applicable to adjacent streams or lakes in like areas.

Fig. 44. Clear Creek, a fine tributary of the Klamath River.

METHODS FOR COUNTING SMALL FISH IN HATCHERIES

By A. C. Taft, Assistant Aquatic Biologist, U. S. Bureau of Fisheries[1]

A PART OF hatchery routine which is often slighted is the accurate determination of the actual production in terms of number, size and weight of the fish produced. Too often the efficiency of a hatchery is based solely on estimates of the number of fish produced and with no reference whatever to the size or weight of these fish. The estimates as to numbers are frequently subject to considerable error as they are based either on the number of dead fish

[1] Published by permission of the U. S. Commissioner of Fisheries.

removed from a given lot subsequent to the time the eggs were eyed or purely upon the judgement of the man in charge. Experience has shown that estimates of numbers of small fish are subject to such errors; that they have no place in any program which contemplates a business like system of accounting for hatcheries.

Any system of accounting is time consuming and costly and in the case of hatcheries the difficulties are increased by the fact that the system must be based upon a count, and the determination of size, of millions of small fish which are delicate and must be handled with care. The fact remains that, as with business firms, hatcheries find it necessary to make an annual report to their stockholders, the sportsmen, and even though it takes time and trouble to accomplish they should be in a position to state clearly and accurately what they have produced during the year.

This information is necessary and desirable, but it is obvious that it is impractical to count millions of young fish one by one. To avoid this difficulty two methods of bulk measurement have long been in use. One is measurement by displacement, and the other is by weight. The two methods are basically similar and are subject to some of the same errors. The displacement method, however, does have several faults which make it less desirable than the weight method.

In general the displacement method is as follows: A straight-sided vessel eight inches to a foot in diameter is used. The diameter of the vessel is determined by the fact that it must be large enough so that fish can be dumped into it from a net without difficulty. A measured quantity of water, sufficient to hold the fish, is placed in the container. The number of fish that is being placed in each shipping can is then counted out and placed in the measuring container after being drained for a brief time in the net. The height to which the water has been raised through the addition of the fish is then determined and marked on the inside of the vessel. For subsequent lots the vessel is partially filled with the measured quantity of water and then fish are added until the water level is apparently level with the mark previously placed in the container.

The procedure for the counting of fish by displacement as outlined above is subject to considerable error due to difficulties of determining the changes in the water level with sufficient accuracy. In a vessel of eight inches diameter the addition of two and one-half ounces of water, or fish, only raises the level about a sixteenth of an inch and as the diameter is increased the change is even less. The difficulty of reading this small change is increased by the fact that the fish are in motion and in practice it is impossible to determine the actual level within an eighth of an inch. Since trout two inches in length will run about twenty to the ounce it is apparent that no great accuracy can be obtained with the displacement method in large containers.

Various modifications in the form of the container have been made so that it is possible to read the level of the water in a tube at the side. This eliminates part of the error caused by the movement of the fish but it does not avoid the necessity for various sizes of containers for the different sizes of fish. In addition, as the container is improved by the addition of various tubes, funnels and valves it soon equals the cost of the scales that are used in the weight method.

Briefly stated, the weight method consists in determining the number of fish per ounce and then calculating the number of ounces needed to make up a given number. If cans are being filled with fish for shipment the number of ounces is determined to start with and is then repeated without further calculation.

In counting by weight the principal difficulty lies in finding a suitable scale. The most important count of the fish is, of course, when they leave the hatchery. In California they are usually transported in ten gallon cans. These cans must be filled rapidly in order that the truckload may be completed and started on its way as soon as possible after the first fish are taken from the trough. In most cases the trucks are not equipped with aerating devices and the time that fish can be held in the cans by manual aeration is limited. One of the most important requirements for the weighing apparatus should therefore be that it take only a little time to weigh out the load for each can. In our work we have found that a spring balance scale with a capacity of 15 pounds in three revolutions of the pointer meets these requirements. This scale has an eight inch white dial with large numerals. The dial shows five pounds in one revolution of the pointer and the smallest divisions are in half ounces. This scale is very simple in construction and has few parts to get out of order, and at the same time its sensitivity is sufficient for counting fish as small as an inch in length with considerable accuracy. As the scale is used in a hanging position it is not apt to be splashed with water and put out of commission in that way. The buckets used with this scale are of twelve quart capacity and are light, weighing only about three pounds.

In practice the procedure is as follows: The bucket containing somewhat less than a gallon of water is hung on the hook below the scale. As the bucket weighs about three pounds and the water about six pounds, the pointer makes one complete revolution of the dial and nearly completes the second revolution. A small amount of water is then poured into the bucket from a dipper, bringing the pointer to zero at the top of the dial. The tare of the bucket and the water is thus taken care of in the first two revolutions of the pointer and the final five pounds of the scale capacity is left for the weighing of fish. The fish are then dipped up from the trough, drained for a few seconds and placed in the bucket. Fish are added until the number of ounces required is reached, the bucket is removed, and the fish transferred to the can. Since more than five pounds of fish are never carried one weighing suffices to fill each can. As the pointer was brought to zero by filling the bucket until it, together with the water, weighed exactly ten pounds there are no deductions or allowances to be made for tare.

In case fish are being counted from one trough to another or the total number of fish in a lot is desired it is only necessary to set down the number of ounces in each bucket, determine the total number of ounces and multiply by the number of fish per ounce. In this case it is not necessary to fill the bucket with any set number of ounces. When cans are being filled, however, one of the advantages of the weight method lies in the fact that it is possible to get very nearly the same number of fish in each can. This is quite an advantage as in many cases losses in the transportation of fish arise from the fact that certain cans are overloaded. This is undoubtedly the cause for many

of the losses in certain cans even when no differences can be seen in the apparent number of fish contained.

In using either the displacement or the weight methods certain simple precautions should always be taken to maintain the accuracy of the count. In either case, just before starting the count it is necessary to determine by actual hand count the number of fish which displace a given amount of water or weigh a certain number of ounces. This is the sample upon which all future calculations of the number of fish are to be based and the more care that is taken with it the greater the accuracy that will be attained.

In many cases the larger fish have a tendency to stay at the upper end of the trough while the smaller and weaker fish lie at the lower end. In such cases if the original sample that is counted is taken from the upper end of the trough where the large fish predominate the final count will underestimate the total number of fish since the larger fish run fewer to the ounce. In case the sample is taken from the lower end the final count will indicate more fish than are actually present. The easiest way to get a fair or random sample is to crowd the fish into the upper quarter or third of the trough. This can be done with a small screen made to fit the trough, and which can be moved up the trough, running the fish before it. This crowding of the fish into the upper end not only makes it possible to get a fair sample but also makes it easier to net them out for counting.

A second precaution must be taken when the fish are picked up in the net to be placed in the counting bucket. When the net is first lifted a large amount of water drains out of it. The net should always be drained approximately the same length of time in order that the amount of water remaining with the fish will be proportionately the same with each net full. It is not necessary that all of the water be drained off, but it is important that the net be handled in the same way throughout the counting. The general tendency is to be more careful with the draining of the original sample, which is counted by hand, than with the work that follows. In taking the original sample it is better to net up one or two hundred fish in the manner which is to be followed in the subsequent work, drain them about as long as will be done in the rest of the work, and then place them in the bucket. After the weight is recorded the fish can be counted and the number per ounce determined. The fish should not be counted before they are weighed for in handling them in this way they will probably not be drained in the same way as the fish that are handled later.

Counting small fish by weight has advantages as a part of hatchery accounting other than the additional accuracy to be attained. The foreman in charge of the hatchery can obtain two other very valuable facts from the weight which will aid him in judging the efficiency of his work from year to year. If he knows the average weight of his fish he can very readily determine their average length from a length weight chart. Greater and greater emphasis is being placed on the size of fish when they are planted and as a consequence it is of increasing importance to know the sizes of fish turned out by the different hatcheries.

Food is the most costly single item in hatchery operation and increasing attention is being given to it and to means of economizing

in its use. Undoubtedly, the clearest check on the amount of food used is through the number of pounds of food used to produce a pound of trout. Knowing the number of pounds of fish produced it is easy for the hatchery foreman to compare the results obtained from year to year with a given amount of food.

To summarize briefly: the accuracy to be obtained by the weight method is greater than with the displacement method and at the same time with no greater expenditure of time or trouble. The procedure to be gone through is very nearly the same in each case and in addition, in counting by weight information is furnished regarding the size of the fish and the proportional amount of food used in rearing them. This latter information can not be determined readily by the displacement method.

DESTRUCTION OF WILD LIFE IN THE MATILIJA FIRE

W. I. Hutchinson, Assistant Regional Forester, U. S. Forest Service

THE MATILIJA fire which swept 220,000 acres in the Santa Barbara National Forest last September caused an estimated damage of $283,340 to timber, watershed cover and property. The value of the deer and other wild animals killed, and the fish which will die when the winter and spring rains wash the ashes from the denuded slopes into the streams can never be computed. Ten years ago the Santa Ynez River was fishless below the Gibraltar Dam because

Fig. 45. The Matilija forest area in the Santa Barbara National Forest before the fire. Photograph courtesy of U. S. Forest Service.

of a fire which laid bare the soil, followed by heavy rains. Forest rangers have reported deer burned to death in many fires and evidence has been gathered that the burning of any part of our foothill and mountain areas not only destroys the habitat of fish and game but results also in the actual killing of wild life and the gradual restriction of hunting and fishing grounds.

Under average conditions most birds and animals are able to save themselves from small forest or chaparral fires. But the Matilija fire was driven by terrific winds. Blinding smoke and rushing flames leaped canyons and circled to cut off avenues of escape for man and beast. Human lives were endangered many times but the wild animals had two enemies to evade—fire and man. At times the common foe brought a truce between all living creatures. During one sudden rush the fire fighters were forced to run for their lives to a barren rocky point, a doubtful refuge in a wilderness of flame. They were joined by two deer, a fox and a bobcat. Unafraid, they remained near the men until the fire burned out, then each went his separate way.

Some indication of the toll of wild life taken by this fire may be gained from the fact that 11 dead deer were found huddled in one spot. A dozen fire scorched carcasses were seen along a few miles of trail. No one knows how many deer died in this 340 square miles of devastation. A survey by the officials of the State Fish and Game Commission showed that raccoons, opossums and skunks were burned. Doves were suffocated by fire gases and it is estimated that half the quail, California's State game bird, in the area were killed. Practically all of the Sespe State Game Refuge was swept clean. The trout in the mountain streams will suffer severely this winter when the rains bring down the ashes and lye from the blackened mountain slopes.

The perpetrator of this wholesale devastation of timber, watersheds and recreational resources will probably remain unknown, although the Secretary of Agriculture has offered $1,000 for his apprehension

Fig. 46. One result of forest fires. Deer killed during the Matilija fire. Photograph courtesy of U. S. Forest Service.

and arrest. Circumstances point to carelessness with either a camp fire or with matches and tobacco as the primary cause. No matter what the cause, the losses sustained in the Matilija fire should be a warning to all sportsmen against careless and thoughtless acts with fire in California.

DESCRIPTION OF A GIANT SQUID TAKEN AT MONTEREY, WITH NOTES ON OTHER SQUID TAKEN OFF THE CALIFORNIA COAST[1]

By J. B. PHILLIPS

WHEN SQUID is mentioned in California, people ordinarily think of the common squid found in our markets and known scientifically as *Loligo opalescens*. Individuals of this species are about a foot long. They occur in countless numbers off our coast in aggregates or schools. It is this schooling habit of the squid and its pelagic nature that makes possible at a certain season of the year a definite fishery for this cephalopod mollusk.

SQUID FISHERY

Monterey has been the chief squid fishing center of the State since the early days of the industry. Squid fishing is one of the oldest fisheries along the coast. The Chinese fished for squid at Monterey years before the advent of sardine canneries. American people in general have not developed a taste for squid. This is probably due to the fact that either they have not tried the product or they have not prepared it in its most palatable form. Small amounts of squid are consumed fresh or canned, but the bulk of the catch is dried for export to the Orient. Details of the squid fishery at Monterey have been given in previous issues of CALIFORNIA FISH AND GAME, so that only a passing mention of it will be made at this time. Squid are captured at night by circling the school with a net, thus impounding the catch. At the dock, the squid destined to be dried are loaded into trucks and transported to the drying fields. Here they are dumped, spread out on the ground, and allowed to sun-dry for several days. The dried squid are then raked up, cleaned of excessive foreign material and sacked or baled for shipment to the Orient.

RARE GIANT SQUID CAST UP ON MONTEREY BEACH

With such an old established fishery based upon a single species of squid, it is only natural that people do think of *Loligo opalescens* when squid is mentioned. Nevertheless, representatives of other species are occasionally taken off the California coast.

[1] Contribution No. 131 from the California State Fisheries Laboratory, December, 1932.

Fig. 47. Giant squid (*Moroteuthis robusta*) taken at Monterey. The head-and-arm bearing portion is held in approximate position to the mantle. Photo by Rolf Bolin, November, 1932.

On the morning of August 23, 1932, a giant squid, hitherto unknown to California waters, was picked up on the beach near Monterey and displayed at the fish market of G. P. Cutino. The giant, which is illustrated in figure 47, bears the scientific name of *Moroteuthis robusta.* This species, according to the available published data, is rare, having been described previously by S. S. Berry from Alaska only. According to Berry this is the largest species of cephalopod—perhaps of

any invertebrate—known to inhabit the Pacific coast of North America. It is said to attain a length of over 14 feet. The nearest relative appears to be *Moroteuthis ingens* from the Magellan region.

G. E. MacGinitie, then of the Hopkins Marine Station (Stanford University), made arrangements whereby the specimen was obtained for the station's collection. Before preservation the specimen had an over-all length, measured from the posterior tip of the body to the ends of the tentacular arms, of slightly over 10 feet. However, after having been in formaldehyde for three months the over-all length of the specimen was about 8⅓ feet. This excessive shrinkage of 1⅔ feet may be attributed in part to the effect of the formaldehyde, and in part, possibly, to the lack of a supporting skeleton in the animal.

The following measurements were made and the description based upon this specimen of *M. robusta* after it had been in formaldehyde for a period of three months. The shrinkage noted above is the equivalent of a 17 per cent loss in the length of the animal. Assuming that the various parts shrank proportionately these measurements will give sufficiently accurate ratios for practical purposes.

Measurements of Moroteuthis robusta from Monterey Bay

	Inches
Total length, including tentacles	100
Total length, excluding tentacles	40
Length of mantle	36
Width of mantle just below head (flat)	8½
Width of mantle at widest part (flat)	10½
Length of fin	15
Width of fin	18
Length of the 8 sessile arms	28
Length of the 2 tentacular arms	60
Length of the head	4
Width of the head	5½
Eye opening	1½ x 1½

General Description of M. robusta

The eight sessile arms, which are drawn out to points at the ends, bear two rows of numerous suckers on short stalks. The suckers commence about two inches up from the head and continue to the tips of the arms. The suckers on the proximal part of the arms are large, and as the arms become pointed distally the suckers diminish markedly in size. There are no hooks on these arms. Occupying about the last 9 inches of the two long tentacular arms (see fig. 1a) are the tentacular clubs. (See fig. 48.) Each club bears an oval-like group of around 20 suckers and pads, called a "fixing apparatus." This is followed by about 34 hooks in two rows. In figure 2, are pictured the tentacle clubs beside one of the sessile arms of *M. robusta*. The sessile arm in the photograph is the thick innermost arm bearing the two rows of huckleberry-like suckers. In figure 2, the arrow points to the "fixing apparatus" of one of the clubs. When these two organs are placed together a strongly adhesive fixing point is obtained, enabling the hooked clubs to be brought into play as capturing and holding organs, much in the same manner as though man had adhesive organs on the inner surface of his wrists allowing his hands and fingers full play.

This adhesive apparatus is similar to that of a smaller form of squid, *Onychoteuthis banksii*, found occasionally at Monterey. However in *O. banksii* this fixing organ is more nearly circular in outline and is definitely raised all around so that it projects slightly from the surface of the tentacle. In *M. robusta* this organ is decidedly oval in

outline and is definitely raised at its anterior margins only, the margin toward the body being rather indefinite. Another point of difference between these two squid is that the longest hooks on the clubs of *O. banksii* are about as long as the fixing apparatus itself, whereas in *M. robusta* the largest hooks are only about one-half as long as the organ.

Fig. 48. Tentacular arms of *M. robusta* shortened so as to show the tentacular clubs compared with one of the eight sucker-bearing sessile arms. The arrow points to the fixing apparatus of one of the clubs. Photo by Rolf Bolin, November, 1932.

OTHER SQUID TAKEN OCCASIONALLY IN MONTEREY AND OFF THE CALIFORNIA COAST

Aside from the common squid of the markets and the giant form just described there are several other squid that are taken occasionally in Monterey Bay and off the California coast. Following are brief descriptions of these forms:

Onychoteuthis banksii

An occasional specimen of *Onychoteuthis banksii* may be in the market catches of squid. This species can be distinguished quite readily from *Loligo opalescens* by its somewhat larger size, long and exceedingly broad fin, and the two very long tentacular arms, the clubs of which bear many long strong hooks. A specimen recently taken had an over-all length of slightly more than 20 inches. In the collection of the Hopkins Marine Station, there is a perfectly preserved specimen about 16 inches in length taken by Tage Skogsberg during one of his ocean hauls.

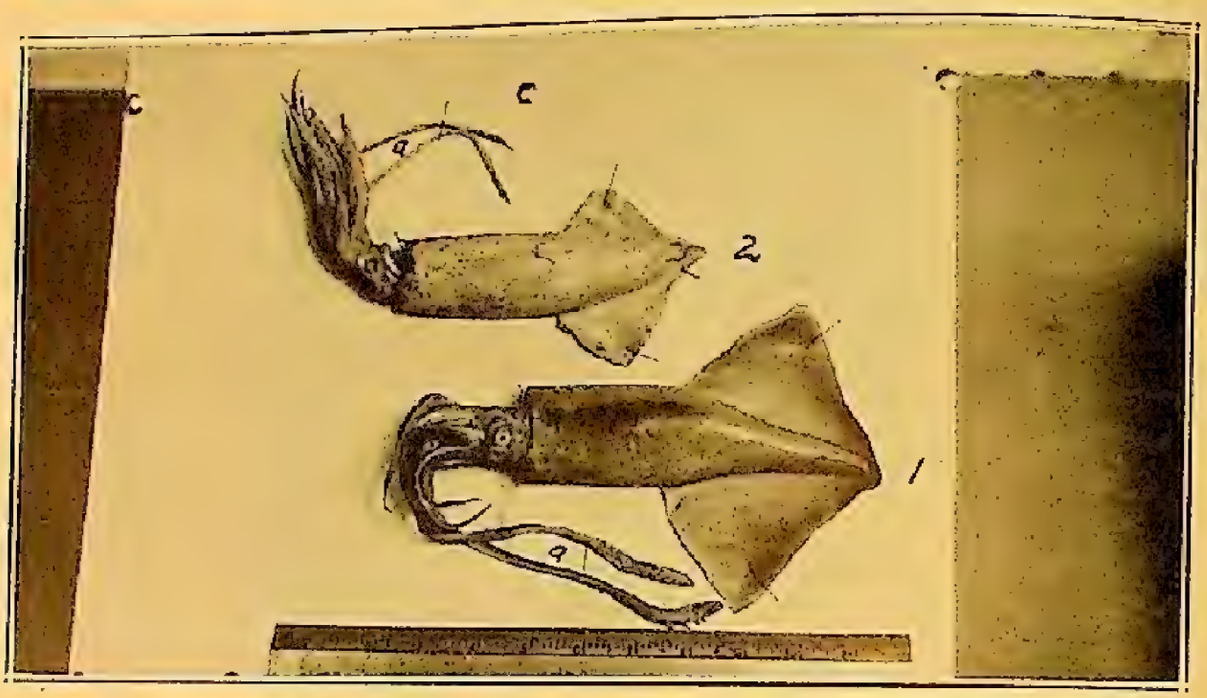

Fig. 49. The common market squid, *Loligo opalescens* (2) compared with *Onychoteuthis banksii* (1)—a form occasionally found in the catches of the common market squid. Note the difference in the proportional size of the fins and in the tentacular arms (a). Photo by J. B. Phillips, November, 1932.

In figure 49, is pictured an average sized specimen of *L. opalescens* (2), and below it a specimen of *O. banksii* (1) from Monterey Bay. The apparent difference in color of the two specimens may be attributed to the use of formaldehyde as a preservative in the case of the former and alcohol in the case of the latter. The heads of the animals have been twisted so that one eye shows on the under side. Note the decided difference in the tentacle arms (marked *a*) of the two species and also in the length and breadth of the fins.

O. banksii can be distinguished from all other West American species except *Moroteuthis robusta* by its double series of powerful hooks on the tentacle club and by the shape of its curious fixing apparatus. From *M. robusta* it can be differentiated ordinarily by the very great difference in size as well as the differences in the tentacle clubs explained above.

Dosidicus gigas

This is a large squid (though not as large as *M. robusta*) which attains a length of several feet. It has been reported frequently from Monterey Bay, the Santa Barbara Islands and other points along our

coast. Most specimens taken have been in poor condition. The principal characteristics of this form are the thick sessile arms which end in pointed tips. These eight arms bear numerous large-toothed, horny-ringed suckers which become modified and much reduced in size at the tips of the arms. On the clubs of the two tentacular arms are four rows of suckers, the two lateral rows being much smaller than the two median rows. This feature serves to differentiate *Dosidicus gigas* from *Moroteuthis robusta* when the former approaches the latter in size. The body is cylindrical, tapering to a blunt point behind. The head, which is rather small in proportion to the rest of the body, has two large prominent eyes. A large funnel is clearly evident, appearing from under the mantle and fitting into a deep groove on the under side of the head. The fins are broad, and from their exterme posterior attachment they extend forward fully half of the mantle length.

Gonatus fabricii

This is rather a puzzling species whose limits are not clearly defined. The use of the generic name only, *Gonatus*, seems advisable. This form is of moderate size. The arms are short and stout. The eight short sessile arms in general have two lateral rows of suckers and two median rows of hooks. The clubs of the two tentacular arms bear numerous rows of suckers and a few median hooks. The body is cylindrical, tapering posteriorly to a point. The head is short and broad with very large conspicuous eyes. The fins are quite broad and extend forward fully half the mantle length.

Rossia pacifica

Rossia pacifica is decidedly smaller in size than the common market squid. The body is relatively short and plump, with large ear-like lateral fins. The flattened head is large and as wide or wider than the body itself. The sessile arms are short and thick and usually completely contractile. The detailed structure in the arms of the two sexes differs greatly. The two dorsal arms in the male are recurved and modified to effect fertilization of eggs in the female. The tentacles are also variable; the inner surfaces are flattened, having a distinct median groove. The tentacle clubs are only slightly expanded at the middle and each bears about eight rows of small delicately toothed suckers.

Meleagroteuthis hoylei

This is a southern form that has been found as far north as Monterey Bay. It is quite distinct and not easily confused with other species. The animal is of moderate size with a short robust body widest at the front and tapering to a rounded point. The fins are short and broad, appearing semicircular in outline. They are about two-fifths the length of the body and are well-lobed in front and behind. Posteriorly the fins are not attached as far as the extreme tip of the body. The head is exceedingly large; it is rounded and not symmetrical. The left eye of the head is extraordinarily large, the diameter of its lid-opening being about twice that of the other eye. Luminous organs are very numerous, especially on the ventral surface of the body.

Galiteuthis phyllura

This is an extraordinary species that should be readily recognized. However, it appears to be very rare off our coast. The elongated body is delicate and of moderate size. The rounded mantle tapers gradually backwards to the fins, continuing between them as a slender twig-like axis drawn out to a point at its extremity. The forward insertion of the long lance-like fins is about midway on the mantle. The fins taper gradually to a point posteriorly. The head is small. On the short sessile arms are two rows of suckers. The tentacle arms are long and the clubs bear two rows of hooks along the middle. At the ends these hooks are replaced by very small suckers.

GENERAL NOTES ON SQUID

Classification

Squid belong to a class of organisms known as Cephalopoda ("head-footed"), a group of marine mollusks which also includes the nautilus, argonaut, cuttlefish and octopus. The phylum Mollusca is a larger group of animals which includes, in addition to the marine cephalopods mentioned, other edible marine animals such as abalones, clams, scallops and mussels. Among other common characters the members of the phylum Mollusca have a distinctive ventral muscular foot. In the cephalopods the eight or ten arms are in reality modified elements of the muscular foot; hence the name "head-footed."

The Cephaloda are divided into two orders: the order Tetrabranchia and the order Dibranchia. The Tetrabranchia is characterized by the presence of four gills, four kidneys, four auricles, a large external shell, and very short arms which bear no suckers. The only representative of this order is the genus *Nautilus*. The Dibranchia is characterized by the presence of only two gills, two kidneys, two auricles, a shell envolped by a mantle, and long arms provided with suckers.

The order Dibranchia, in turn, is divided into two sub-orders, called Decapoda and Octopoda. The decapods are differentiated mainly by the presence of ten arms, eight long and two short. The arms bear suckers and sometimes hooks. This sub-order includes the squid and cuttlefish. The octopods are differentiated mainly by the presence of only eight sucker-bearing arms of equal length. This sub-order includes the octopus and the paper-nautilus or argonaut.

In squid the shell is embedded in the dorsal part of the mantle and is frequently reduced to a chitinous remnant, descriptively called a "pen." In some species of squid this shell is not chitinous but is reinforced by a calcareous material; in these cases the shell is called "cuttlebone." The members of the squid group bearing such a cuttlebone may be termed "cuttlefish." The mouth of a squid is situated in a central position just below the base and within the circle of arms. The mouth is armed with a pair of beak-like jaws resembling those of a parrot. Much of the locomotion of the animal is accomplished by the rapid expulsion of water through the tubular siphon which appears under the mantle in the head region. This expulsion of water is effected by the sudden contraction of the muscular mantle, causing the squid to be propelled backward. This form of locomotion is particularly effective when enemies are suddenly encountered. Another means of

defense found in all squid is the "ink bag." This is connected by a duct leading to the exterior in the anal region. "Ink" can be ejected to confuse a pursuing enemy. The original India inks of commerce were made of sepia or "ink" of the cuttlefish.

REAL GIANTS IN THE NORTH ATLANTIC OCEAN

Geological records, millions of years old, show that the earlier species of squid were all shell-bearing. It is only in recent times that the outer shell has been replaced by a compact inner quill or cuttlebone. This change has evidently permitted the great body expansion and high organization shown by the existing squid, some of which have become the largest of invertebrates.

The specimens of giant squid taken off the Pacific coast might be termed "pygmy-giants" when compared with some of the squid from the western Atlantic Ocean. One might expect the largest forms to be found in the warmer waters of the tropical regions; however, records show that this is not the case. The largest squid known belong to the genus *Architeuthis*. They are found down to considerable depths in the circumpolar regions of the Atlantic.

The U. S. Bureau of Fisheries records one of these giants taken off the Grand Banks as having an over-all length of 55 feet (about 5½ times that of the specimen from Monterey Bay). The Grand Banks specimen had a body length of 20 feet and a body circumference of 12 feet. The diameter of the largest suckers was 2¾ inches and the eye-openings were 7 by 9 inches.

Of another specimen only two arms, each 42 feet long, were found. Based on the proportional measurements of the above specimen this latter specimen should have an estimated length of about 66 feet.

Usually, only portions of these giants are recovered. The squid ordinarily come to the surface only at night or when disabled by enemies or disease. Squid sometimes fall prey to large fishes or whales. That whales consider these enormous cephalopods good eating is evidenced by the stomach contents of captured whales. The arms of squid, aided by the accompanying suckers, can exert a tenacious leverage, for imprints of this action are often found on the tough hides of captured whales.

TALES ABOUT GIANT SQUID

About the giant squid as well as giant octopus has been woven many a tale in the earlier centuries. One of these old tales, the accuracy of which can not be vouched, tells of a giant squid, which, coming to the surface while two sailors were scraping a ship, wrapped its long arms around them and dragged them down out of sight. Another story is related by an African slaver whose ship almost capsized when a huge squid came to the surface and wrapped its arms about the masts. According to the narration, only the prompt action of the sailors in cutting off the arms of the squid saved the vessel. Other tales are in a similar vein. For lack of proof these tales must be pigeon-holed with some of our present day shark tales.

Nevertheless there is probably some foundation to the stories concerning sea serpents and sea monsters. Authentic records show that the tentacular arms of some forms of squid attain a length of 42 feet

and the diameter of a man's wrist. Imagine the surface at dusk. An expanded club, perhaps armed with large chitinous hooks, is thrust gropingly from the depths. A long sinuous body follows. Would it require a vivid imagination to mistake this for the incarnation of a fabulous serpent of the sea? This interpretation would be especially plausible to a person in a condition described nautically as "three sheets in the wind."

REFERENCES

Bartsch, Paul
1917. Pirates of the deep—stories of the squid and octopus. Smithsonian Institution, Annual Report for 1916, pp. 347–375.

Berry, Samuel Stillman
1912. A review of the cephalopods of western North America. U. S. Bureau of Fisheries, Bulletin, vol. 30, for 1910, pp. 267–336, pls.
1912. On a cephalopod new to California with a note on another species. Laguna Marine Laboratory, First Annual Report, pp. 83–87.
1920. Light reproduction in cephalopods. Biological Bulletin (Marine biological laboratory, Woods Hole), vol. 38, no. 3.

Classic, Ralph F.
1929. Monterey squid fishery. California Fish & Game, vol. 15, no. 4, pp. 317–320.

Cooke, A. H.
1913. Molluscs. *In* The Cambridge Natural History, ed. by S. F. Harmer and A. E. Shipley, vol. 3, pp. 1–444.

Heath, Harold
1917. Devilfish and squid. California Fish & Game, vol. 3, no. 3, pp. 103–108.

Scofield, W. L.
1924. Squid at Monterey. California Fish & Game, vol. 10, no. 4, pp. 176–182.

CHANGING ABUNDANCE OF THE CALIFORNIA SARDINE, MEASURED BY LENGTH OF SCOUTING TIME[1]

By Frances N. Clark

INTRODUCTION

CHANGES in abundance of many species of fish have been measured in returns to the fishermen per unit of effort. This return is customarily calculated in pounds per catch, per fishing day, or per hour. But such units of effort, based on poundage, have not given a true measure of the changes in abundance of the California sardine. Throughout the history of the fishery the poundage delivered by the fishermen has been determined by the demands of the canneries and not by the availability of the fish. The packers are assured a more constant supply when many boats operate and a limit is placed on each boat's daily catch than when few boats operate without restriction. Because of these "limits," measures of supply based on pounds delivered reflect the changes in limits throughout the years and not changes in availability of sardines. To circumvent this influence of limits, this study of changes in sardine abundance was based on variations in length of scouting time.

[1] Contribution No. 132 from the California State Fisheries Laboratory. December, 1932.

DEFINITION OF SCOUTING TIME

By scouting time is meant the length of time required by the fishermen to locate a school of fish after the arrival of the boat on the fishing ground. California sardine fishing is carried on at night during the dark of the moon. In general, fishermen plan to be on the fishing ground when darkness falls. For this reason the onset of darkness has been used as the point of origin for scouting time. The time elapsed between the beginning of darkness and the time of the first haul is here termed the length of scouting time.

METHODS

The data on which this study are based were secured from the fishermen over a period of years. Information has been gathered semi-weekly from five boat captains throughout each sardine season. These data include the time when the first haul was made during the previous night's fishing. The number of hours that elapsed between the hour of moonset or one hour after sunset and the time of making this haul constituted the length of scouting time for a specific boat on a given night. The catches used for this study were those made on nights when there were six or more hours of darkness. This procedure was necessary because on nights when there were less than approximately six hours of darkness the number of hours of darkness unduly influenced the length of scouting time.

Fishing gear has changed during the period of the study and perhaps this change has caused some variations in methods of locating schools of fish. To make all data comparable purse seine catches were handled separately from the lampara and ring net catches. For the Monterey data purse seine catches were not used in the study. For the San Pedro data the average scouting time for any given season was calculated from the purse seine, lampara and ring net catches but the method used eliminated the influence of possible differences in fishing methods.

AVERAGE SEASON

Figures 50 and 51 show the average length of scouting time for each month of an average season. The data for Monterey (fig. 50) are based on the month by month averages of 12 seasons, 1920–1921 to

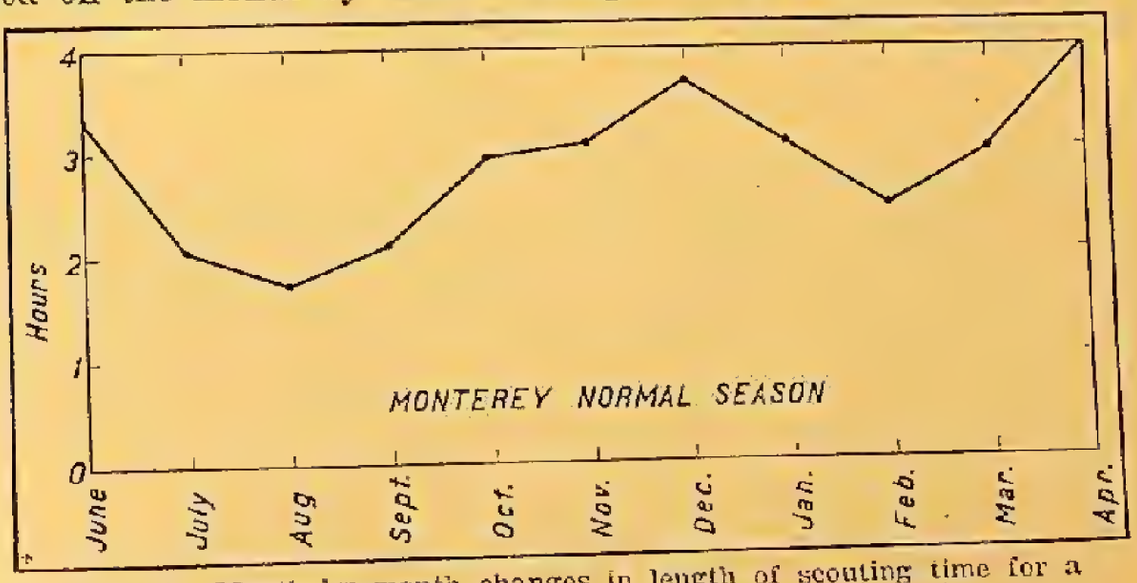

Fig. 50. Month by month changes in length of scouting time for a normal or average season in the Monterey fishery.

1931–1932, and those for San Pedro (fig. 51) on the averages for seven seasons, 1925–1926 to 1931–1932.

The abundance of sardines, as measured by length of scouting time, apparently varies within each fishing season. At the beginning and close of the season sardines are evidently less available than during the height of the fishing season. This is true of both Monterey and San Pedro. At San Pedro the abundance appears to be practically constant from November to February. At Monterey, on the other hand, the data indicate that the period of greatest abundance is from July to September. Sardines become less available from October to December, and again increase in abundance during January and February. This decrease in abundance of Monterey sardines during the late fall and early winter corresponds to the "period of scarcity" demonstrated in previous publications and recognized by both fishermen and canners.

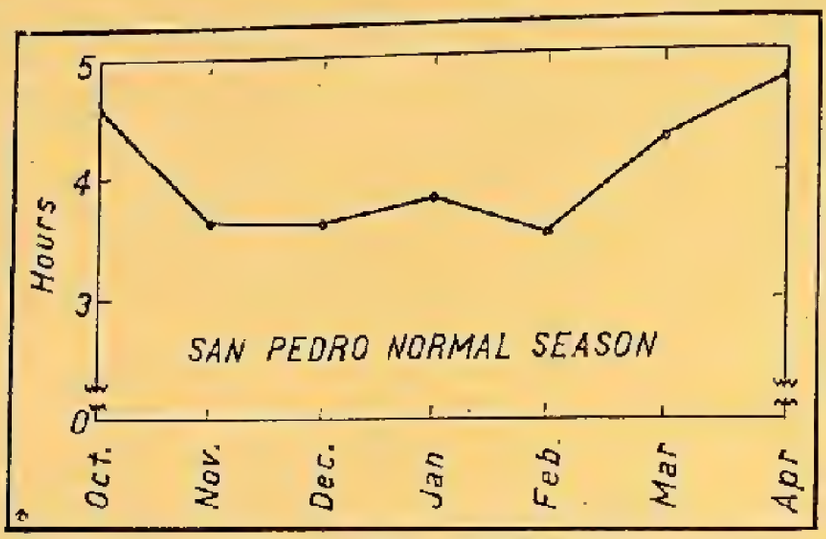

Fig. 51. Month by month changes in length of scouting time for a normal or average season in the San Pedro fishery.

Because of these variations in abundance within each season, a simple arithmetic average of all catches did not give an accurate measure of the length of scouting time. To eliminate the seasonal influence, the monthly averages were expressed as percentages of the normal monthly average and the geometric mean of these percentages was computed for each season.[1]

MONTEREY FISHERY

At both Monterey and San Pedro the fall fishery differs in character from the winter fishery. The fall fishery is composed of adolescent and young adult fish whereas the winter fishery is maintained by the larger, older adults. Because of these characteristic differences in the fall and winter fisheries, they have been treated separately in this study. The months from August to November comprise the Monterey fall fishery and December to February the winter fishery.

[1] For a detailed discussion of methods of boat catch analysis, see:
Clark, G. H. The California halibut (*Paralichthys californicus*) and an analysis of boat catches. Calif. Div. of Fish and Game, Fish Bull., no. 32, pp. 20–43.
Craig, J. A. An analysis of the catch statistics of the striped bass (*Roccus lineatus*) fishery of California. Calif. Div. of Fish and Game, Fish Bull., no. 24, pp. 1–43.

The seasonal variations in length of scouting time for the Monterey fall fishery are shown in figure 52 and for the winter fishery in figure 53. For the fall fishery a straight line fitted to the data, by the method of least squares, has a decidedly upward trend. This suggests that, during the latter part of the twelve seasons studied, the length of time required to locate sardines in the fall months has increased. If length of scouting time is an indication of sardine abundance, this also indicates that Monterey fall sardines have decreased in abundance over the time interval studied.

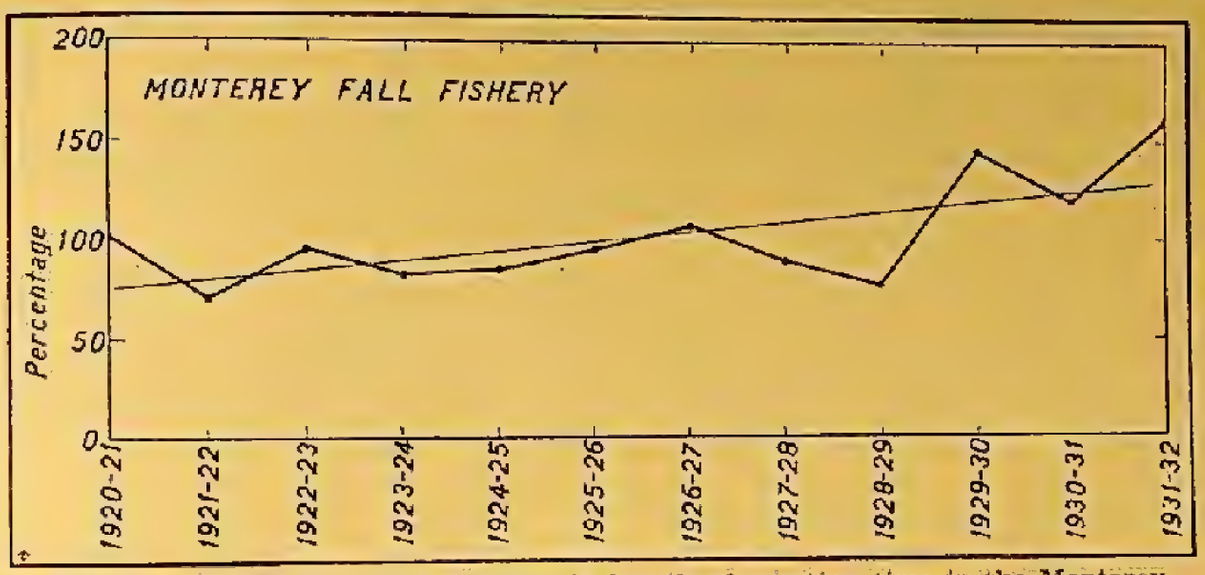

Fig. 52. Season by season changes in length of scouting time in the Monterey fall fishery.

Figure 53 shows the variations in average scouting time for the Monterey winter fishery. The averages have fluctuated greatly from season to season. Although a straight line fitted to the data has a slightly upward trend, the averages are too variable to demonstrate any significant changes in the abundance of the Monterey winter fish.

SAN PEDRO FISHERY

The average length of scouting time was also calculated separately for the San Pedro fall and winter fisheries. The fall fishery comprises November and December and the winter embraces January, February and March.

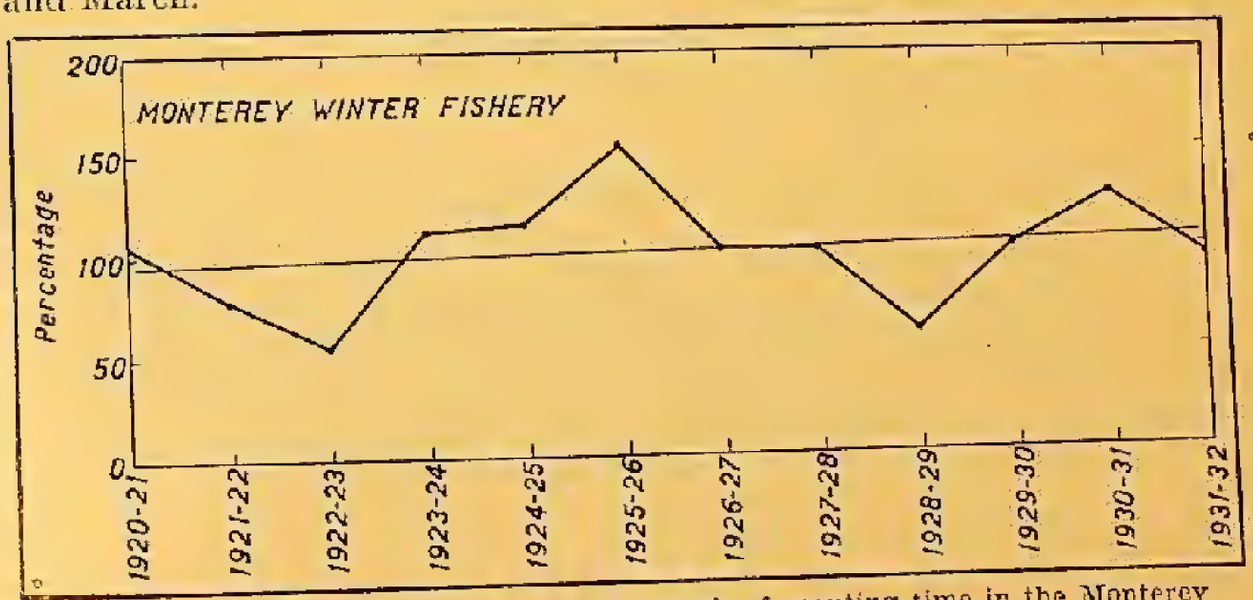

Fig. 53. Season by season changes in length of scouting time in the Monterey winter fishery.

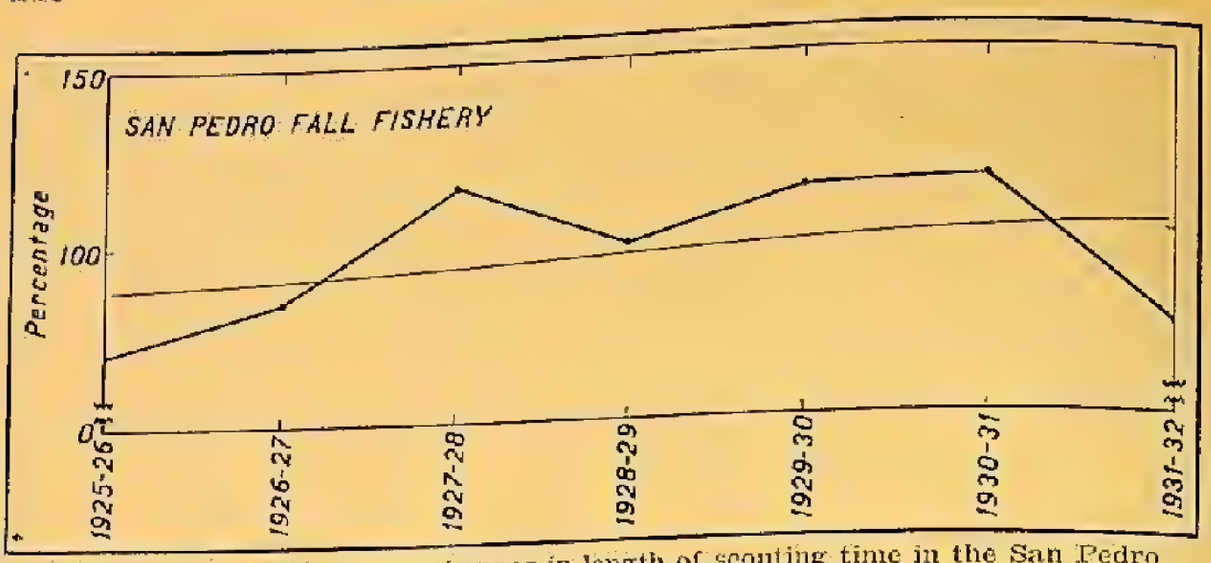

Fig. 54. Season by season changes in length of scouting time in the San Pedro fall fishery.

The changes from season to season in the average scouting time for the fall fishery are shown in figure 54. As at Monterey, a straight line fitted to the averages has an upward trend suggesting a similar decrease in abundance of the San Pedro fall fish. In figure 55 are presented the seasonal averages for the winter fishery. For these averages the fitted straight line has a slightly downward trend, but this is too slight to indicate any significant change in the abundance of the San Pedro winter fish.

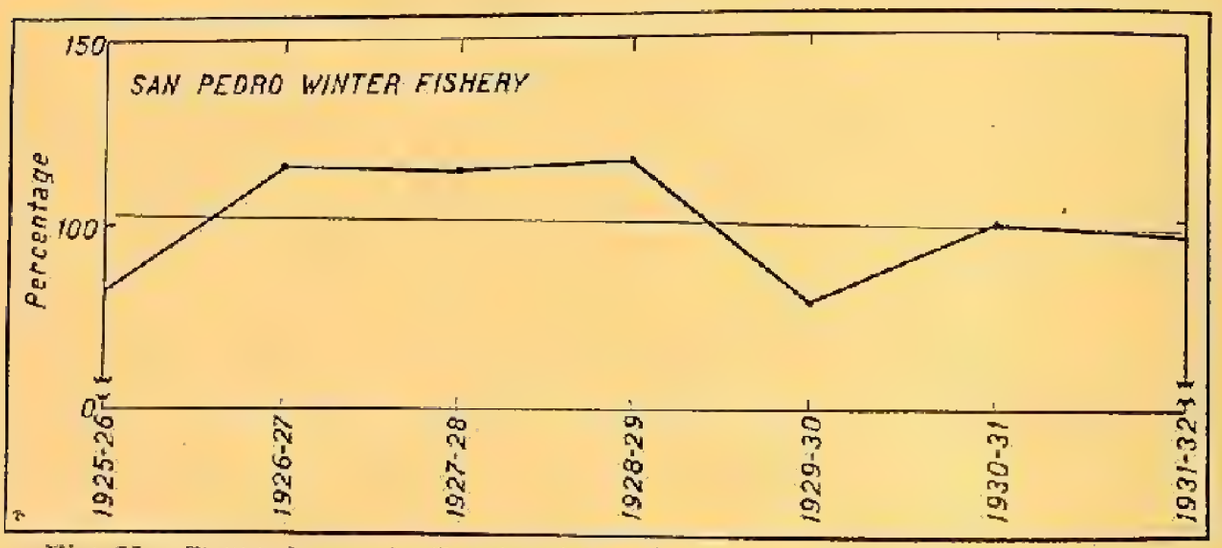

Fig. 55. Season by season changes in length of scouting time in the San Pedro winter fishery.

CONCLUSIONS

This study suggests that the winter sardines along the California coast have experienced no important changes in abundance during the past twelve seasons. The fall fish, on the other hand, appear to be less abundant now than in former years. Other independent studies indicate the same conditions of sardine abundance.

The cause of the decrease in abundance of fall fish is associated presumably with the scanty survival of the year classes spawned since 1926 or 1927. Since these dates, only two fairly abundant year classes have entered the sardine fishery, whereas prior to that time several successful spawnings followed in close succession. Because the fall

fishery is supported by smaller sardines comprising one, two or at the most three-year classes, the poor survival of a single year's spawn decreases the supply of fall fish two or three years later. The winter fishery, on the other hand, draws upon many year classes and the scarcity of one or two has little influence on the total abundance of available winter fish.

At the same time it must not be forgotten that a scarcity of fall fish, continued over a period of years, will eventually produce a decrease in the abundance of winter fish. Such a scarcity may occur in the winter fishery in the seasons beginning with 1933 or 1934. A period of several years has elapsed during which the fall fish have been decreasing in abundance. During these years the fishermen have been taking their toll from these sparsely represented fall groups. Especially is this true at Monterey where the major part of each season's sardine fishing is concentrated in the fall months. That the winter fishery will be adversely affected in the near future seems inevitable.

The concentration of the Monterey fishery on the fall population is further to be regretted because these fish are composed of adolescent and young adults only. The taking of so many fish before they have spawned or have spawned but once or twice much more seriously decimates a population than the catching of a similar poundage or even a similar number of older adults.

A readjustment of the California sardine fishing season so as to concentrate the fishery in the winter months would help greatly to maintain the present population abundance.

REFERENCES

Clark, Frances N.
1930. Seasonal changes in the daily average length of the California sardine (*Sardina caerulea*). Calif. Div. of Fish & Game, Fish Bull., no. 26, pp. 1–20.
1931. Dominant size-groups and their influence in the fishery for the California sardine (*Sardina caerulea*). Calif. Div. of Fish & Game, Fish Bull., no. 31, pp. 7–42.
Mss. Maturity of the California sardine (*Sardina caerulea*) determined by ova diameter measurements.

Fry, Donald H., Jr.
1931. The ring net, half ring net, or purse lampara in the fisheries of California. Calif. Div. of Fish & Game, Fish Bull., no. 27, pp. 1–65.

Higgins, Elmer, and Harlan B. Holmes.
1921. Methods of sardine fishing in southern California. Calif. Fish & Game, vol. 7, no. 4, pp. 219–237.

Lindner, Milton J.
1930. Fishing localities at Monterey from November, 1919, to March, 1929, for the California sardine (*Sardina caerulea*). Calif. Div. of Fish & Game, Fish Bull., no. 25, pp. 8–27.

Phillips, J. B.
1930. Success of the purse seine boat in the sardine fishery at Monterey, California (1929–1930 fishing season). Calif. Div. Fish & Game, Fish Bull., no. 23, pp. 1–28.

Scofield, W. L.
1929. Sardine fishing methods at Monterey, California. Calif. Div. Fish & Game, Fish Bull., no. 19, pp. 1–61.

REPORT OF THE COMMISSIONERS OF FISHERIES OF THE STATE OF CALIFORNIA FOR THE YEARS 1872 AND 1873

REPORT

To His Excellency NEWTON BOOTH,
Governor of California:

The Commissioners of Fisheries for the State of California, appointed under an act of the Legislature entitled "An act to provide for the restoration and preservation of fish in waters of this State," approved April second, eighteen hundred and seventy, respectfully submit their Second Biennial Report.

REPORT

Your Commissioners, in pursuance of the plan contemplated in their last report, proceeded to open correspondence with the most noted fish culturists in the east, and also with the United States Fish Commissioner at Washington City, upon the subject of obtaining an additional supply of shad, and also a large variety of other food fishes from the eastern lakes and sea coast.

By the kindness of the United States Commissioner of Fisheries, the Hon. Spencer F. Baird, we were allowed to avail ourselves of the services of Mr. Livingstone Stone, attached to the United States Commission, and engaged in transferring salmon eggs from California to the waters flowing into the Atlantic. Mr. Stone's high reputation as a successful breeder of fish, as well as a writer upon the subject of Pisciculture, not only gave us confidence in the success of the enterprise, but also led us to enlarge and amplify the scope and range of the undertaking.

In this view we made arrangements with Mr. Stone, for him to proceed to the eastern states, and there collect a supply of shad, eels, black bass, white fish, Tautogs, striped bass, blue fish, and lobsters.

To carry into effect these plans, we chartered from the Central Pacific R. R. Co. a special car, to be placed at our disposal at a given point at the east, and there to await the necessary time for being fitted up for the purpose, and to receive its freight of living fish. All the requisite arrangements for the transit of this car over the different lines of roads, as well as for its necessary stoppages and delays at different points where fish were to be taken in, had been most completely made by our colleague, Mr. B. B. Redding, through the agency of the different railroad managers; and on the seventeenth day of March, 1873, Mr. Stone left San Francisco, to carry out, if possible, the plan of your Commissioners, to transport a car-load of living fish from the Atlantic to the Pacific Ocean.

Referring to this expedition Mr. Stone says:

In accordance with instructions received from the Fish Commissioners of the State of California, I left San Francisco for the eastern

coast on the seventeenth day of March, 1873, for the purpose of procuring a stock of the best varieties of eastern fish, and transporting them alive across the continent, with a view to introducing these varieties into the public waters of California.

My plan of operations for the whole undertaking was: First—To collect the fish at some favorable point at the East, where they could be kept alive until everything was ready for the journey. Second—To fit up a car with the apparatus most suitable for transporting living fish. And third—To take this car when loaded, to California, in the least possible time, and without any transfer of its contents. This plan was successfully carried into practice up to the time of the accident just beyond Omaha.

The first installment of living fish intended for the California car, arrived at Charlestown, New Hampshire, the point of rendezvous, on the seventh of May. It consisted of eighty-two Black Bass, *Grystes facciatus*, Glass-eyed perch, *Lucio perca*, and Bull heads, *Penrelodus*, and about three hundred thousand eggs of the *Perca flauerscurs* and the *Lucio perca*.

These fish were collected at Lake Champlain, and at the Missisquoi River in Vermont, and were taken a journey of thirty hours by rail, before reaching Charlestown. They nevertheless bore their trip admirably, and arrived at their destination in first rate order.

The next two weeks were spent in fitting up the car which had arrived at Charlestown, N. H., and making other preparations for the difficult undertaking in prospect. Arrangements had been previously made, at the suggestion of Hon. Spencer F. Baird, U. S. Commissioner of Fisheries, with Mr. Myron Green, at Castleton, on the Hudson, for a supply of young Shad, and fresh water Eels.

And also, with Capt. Orinal Edwards, of Woods Hole, Mass., for young Lobsters, and other salt fish. The Eastern Trout, Salmon fontanalis, were to be taken from the Cold Spring Trout Ponds, at Charlestown. The large Lobsters were to come from Johnson & Lorings' establishment, at Boston, and Mr. Myron Green was dispatched to the Raritan River for Catfish.

The equipment of the car having been completed, and everything being ready, the third day of June, 1873, was set for our departure. At midnight of June 2d, Mr. W. S. Perrin arrived from Boston with a special car having on board the Lobsters, Oysters, small Lobsters, salt water Eels, Tautogs, and reserves of ocean water. We began at daylight the next morning, filling the tanks in the car and loading in the fish, and by one o'clock in the afternoon, everything was ready, and at a quarter past two on Tuesday, June 3d, the California Aquarium Car started on its journey.

The car was furnished by the Central Pacific R. R. Co., and was one of their fruit cars, intended for quick trips across the continent. It was twenty-seven feet long and eight feet wide, and was provided with a Westinghouse airbrake and Miller platform, which enabled us to take it along with passenger trains.

At one end of the car was a stationary tank, built of two-inch plank, lined with zinc, and occupying the whole width of the car, and eight feet of its length.

This tank was two feet and eight inches deep, and held, when full, about ten thousand pounds of water.

At the other end of the car was a large ice box, the reserves of sea water, six large cases of lobsters, and a barrel of oysters.

In the center of the car, and occupying nearly all the room in it, were the other portable tanks for carrying the fish. Our beds were on the top of the large stationary tank, which, of course was covered. The large tank was also arranged so that we could take on water on a large scale from the water works at the railroad stations en route. This proved to be a very great convenience, and was in fact indispensable.

When we left Charlestown, N. H., the car contained upward of—

60 Black Bass from Lake Champlain—*Grystes fasciatus.*
11 Glass-eyed Perch, from Lake Champlain—*Lucio perca.*
110 Yellow Perch from Missisquoi River—*Perca flavescens.*
80 Young Yellow Perch from Missisquoi River—*Perca flavescens.*
12 Bull Heads (Horn pouts), from Missisquoi River—*Pimelodus.*
110 Catfish from Raritan River—*Pimelodus.*
20 Tautogs from near Martha's Vineyard—*Tautoga Americana.*
1500 Salt Water Eels from Martha's Vineyard—*Anguilla.*
1000 Young Trout from Charlestown, N. H., *Salmo fontinalis.*
162 Lobsters from Massachusetts Bay and Wood's Hole.
1 Barrel of Oysters from Massachusetts Bay.
Supplies of Minnows for feed fish.

The Black Bass, Bull Heads, Cat Fish, and part of the Lobsters, were full grown and heavy with spawn.

Besides the fish above enumerated, I took on at Albany—

40,000 Fresh Water Eels from the Hudson, and arranged for 20,000 Shad and Shad Eggs, Alosa praestabilis, from the Hudson, to overtake us at Chicago.

The receptacles for holding the fish consisted of—

1 large stationary tank, 8 feet square and 2 feet 8 inches deep.
1 round wooden 70-gallon tank.
1 round 50-gallon tank.
3 round 30-gallon tanks.
3 conical-shaped 30-gallon tanks.
6 conical 10-gallon tin cans.
1 conical 15-gallon tin can.
3 round 9-gallon tin cans.
2 thirty-five gallon casks.
6 large cases (containing the Lobsters).

The total capacity of the whole, excluding the Lobster cases, being about 16,000 pounds of water.

Besides the vessels for holding the fish the car contained the following articles:

1 large 120-gallon cask, filled with ocean water.
1 sixty-gallon cask, filled with ocean water.
1 large ice box.
½ barrel of live moss.
½ barrel of water plants.
Curd and meal for feed.
1 bushel of salt for killing parasites.

The aerating apparatus referred to—

1 alcohol stove.
1 set carpenter's tools.
2 lanterns.
2 hammocks.
2 spring beds.
2 mattresses and pillow.
2 sets bedclothes.
1 broom.
1 lot green sod.
2 thermometers.
Pipes, spouts, and syphons, for taking in and letting off water.
1 long-handled dip net.
2 short-handled dip nets.
Movable steps to door of car.
Sundry barrels, pails, dippers, etc.
Maps, with stations marked where we knew the water to be good or bad.
Our trunks, valises, and private baggage.

When the car left Charlestown there were four of us in it—Mr. W. T. Perrin, of Grantville, Mass.; Mr. Myron Green, of Highgate, Vermont; Mr. Edward Osgood, of Charlestown, N. H., and myself. We arrived at Albany at 11.30 p.m. the same evening, all the fish doing well, and the water in the tanks standing at 45 degrees F. Here we took on the 40,000 Eels mentioned above, and half a ton of ice. We also left Mr. Myron Green here to go to the New York Shad Hatching Works, at Castleton on the Hudson, and get a supply of young Shad.

On my urgent application to the New York Central Railroad authorities, that road took us with their passenger train, which was due to leave Albany at 2.40 a.m. on the same night. We reached Suspension Bridge about noon and left for Detroit with a passenger train on the Great Western Railroad. We took on ice and water at Hamilton, Canada, and reached the boat at Detroit ferry about 11 p.m. the same day, Wednesday, June 4th, all the fish being in good order, except the Lobsters, which were dying in considerable numbers. The ferry boat being just filled, without the Aquariam Car, they left us east of the river all night, and it being very warm, I spent the rest of the night till daylight looking up ice, of which I at last obtained a ton and a half.

Leaving Detroit that morning—Thursday, June 5th—we proceeded directly to Niles, Michigan, with a passenger train, via the Michigan Central Railroad. We had now come all the way with passenger trains, and had we known this beforehand we need not have lost any time in bringing on the Shad; as it was, however, we expected to make slow time on freight trains from Albany to Chicago, and I here arranged to have the Shad brought on by express from Albany two days after we left that point. These two days we had now on our hands, and it was very aggravating to be obliged to lose so much time when time was so precious. There was no help for it, however, and as I thought it would be better to wait part of the time on the road than to spend the whole of the two days in Chicago, I had the car dropped at Niles, Michigan, and we remained there till 6.10 the next morning—Friday, June 6th—when we went on to Chicago, after taking on ice

and water, and catching some minnows to feed the large fish with. We entered Chicago about 10 o'clock on Friday morning, all the fish doing well, except the Lobsters and Eels.

The temperatures at which I aimed to keep the different varieties of fish, were as follows:

	Fahrenheit
Catfish	50 deg.
Fresh Water Eels	45 to 50 deg.
Tautogs	45 deg.
Salt Water Eels	45 deg.
Black Bass	42 deg.
Yellow Perch	42 deg.
Bullheads	42 deg.
Glass-eyed Perch	42 deg.
Trout	38 deg.
Lobsters	34 to 36 deg.
Oysters	34 to 36 deg.

From the experience which I have now had, however, I would advise a change with some of the fish, which would make the temperature as follows:

	Fahrenheit
Catfish	50 deg.
Fresh Water Eels	50 deg.
Bullheads	48 deg.
Glass-eyed Perch	48 deg.
Yellow Perch	45 to 48 deg.
Black Bass	42 to 45 deg.
Salt Water Eels	42 to 45 deg.
Tautogs	42 to 45 deg.
Trout	36 to 38 deg.
Lobsters	36 to 38 deg.
Oysters	34 to 36 deg.

Mr. Myron Green rejoined us with the Shad the next morning, Saturday, June 7th, and at 10.15 a.m. the same day, after having taken on three tons of ice and three tons of Lake Michigan water, we left Chicago for Omaha, via the Chicago and Northwestern Railroad.

We took on water again at Cedar Rapids, Iowa, and arrived at Omaha, at 11 o'clock, on the morning of Sunday, June 8th. Through the courtesy of Mr. C. B. Havens, the train dispatcher of the Union Pacific Railroad, who detailed an engine to take our car to the ice house at the Union Pacific shops, we were enabled to take on a ton and a half of ice, and about one o'clock we started westward again. We were now on our sixth day out, and everything was promising well. All the dead eels had been removed, and we had 20,000 or 30,000 left. The mortality of the lobsters was on the decrease, and we still had over forty alive and in good condition. All the other fish were in splendid order. We had ice and water enough on board to take us, if necessary to the Sierra Nevada—certainly with what supplies we could get in the Wahsatch Mountains, where the water is good. The circumstance of the fish having lived so well up to this time, gave us a good deal of confidence, and we were encouraged to hope that they would continue to do well to the end of their journey.

After leaving Omaha we stowed away as well as we could the immense amount of ice we had on the car, and having regulated the temperature of all the tanks, and aerated the water all around, we made our tea and were sitting down to dinner, when suddenly there came a terrible crash, and tanks, ice, and everything in the car seemed to strike us in every direction. We were, every one of us, at once wedged in by the heavy weights upon us, so that we could not move or stir. A

moment after, the car began to fill rapidly with water, and the heavy weights upon us began to loosen, and, in some unaccountable way, we were washed out into the river. Swimming around our car, we climbed up on one end of it, which was still out of water, and looked around to see where we were. We found our car detached from the train, both couplings having parted. The tender was out of sight, and the upper end of our car resting on it. The engine was three-fourths under water, and one man in the engine cab crushed to death. Two men were floating down the swift current in a drowning condition, and the balance of the train still stood on the track, with the forward car within a very few inches of the water's edge. The Westinghouse air-brake had saved the train. If we had been without it, the destruction would have been fearful.

One look was sufficient to show that the contents of the Aquarium Car were a total loss. No care or labor had been spared in bringing the fish to this point, and now, almost on the verge of success, everything was lost.

I immediately telegraphed the state of affairs to Mr. S. R. Throckmorton, Chairman of the California Fish Commissioners, and to Hon. Spencer F. Baird, the head of the U. S. Commission at Washington. I received instructions by telegraph, the next morning to return East immediately with my assistants, and take on a shipment of young Shad to California, under the auspices of the United States Fish Commission.

In pursuance of these instructions, I went East, and having obtained 40,000 young Shad from the New York State Hatching Works, at Castleton, on the Hudson, I left Albany a second time, at 11.30 p.m. on the 25th of June, 1873, in company with Mr. W. T. Perrin and Mr. Myron Green, my assistants on the Aquarium Car. We were also accompanied as far as Omaha on this trip by Mr. H. M. Webster, whose experience in carrying live Shad was, in this instance, of the greatest value.

On our arrival at Ogden, Utah, I left 5,000 of the Shad, in first-rate order, in charge of Mr. Rockwood, Superintendent of Fisheries at Salt Lake City, to be introduced into Great Salt Lake, and continued with the other 35,000 to Sacramento, Cal., where we arrived at half past one in the afternoon of the second day of July—the fish appearing in every respect as fresh and lively as when they left the Hudson a week before.

We deposited them that night, at ten minutes past nine, in the Sacramento River, just above the Railroad Bridge, at Tehama—the whole undertaking from beginning to end, having been a perfect success.

Immediately upon hearing of the loss of the Aquarium car, we telegraphed a remittance to Mr. Stone at Omaha, and directed him to repair at once to the Hudson River, and bring out, while yet in time, all the young Shad which his now reduced facilities would permit.

Mr. Stone at once proceeded East and, communicating, by telegram, with Mr. Spencer F. Baird, U. S. Fish Commissioner, received from him not only prompt attention but was also furnished by Mr. Baird, for the California Commission, all of the Shad which the U. S. Commission could spare, forty thousand in number, which were immediately sent through to California, at the expense of the U. S. Fish Commission, under the care of Mr. Stone, free of all charges, for

which and for the many kind and valuable aids extended to us by Mr. Baird, this Commission takes this public opportunity of returning their most grateful thanks.

Upon receiving advice of the approach of this shipment, one of the Commissioners repaired to Sacramento, and there met the incoming car with a fresh supply of water and ice. The little immigrants were found to be all alive and in excellent spirits, and after receiving a fresh supply of ice and water, proceeded on their journey to Tehama, on the Sacramento River, and there that same night they were successfully placed in the waters which flow into the Pacific.

In the Spring of eighteen hundred and seventy-two, we opened correspondence with Mr. Seth Green for an additional supply of Shad, but the early Summer and excessive heat of the Eastern States at that time compelled us to abandon the attempt for the season.

In the meantime, viz., in the Fall of 1872, we received advice of a shipment made to us by Mr. Baird, of White Fish Eggs, and we immediately took measures to hatch them and place them in the waters of the State.

In view of this we caused an examination of the different lakes into which they could be placed with the best prospect of success, which resulted in our selecting Clear Lake as affording most of the necessary conditions. Among these conditions is an essential one, namely: That it may be seined without destroying other valuable fish, there being few or no fish in that lake the destruction of which by seining would be any loss, or which at any rate would not be most profitably replaced by the White Fish which can be taken only by seining or trapping. The climate also of Clear Lake seemed to us to be the best within reach, remembering always that the eggs of the White Fish are very delicate and will not bear rough transportation; as it was, in the first attempt all of the eggs perished, and in the second effort, although great pains were taken, a very large proportion of the eggs perished on the way.

Having selected what we deemed a proper place, we erected a hatching house under the charge of Mr. J. G. Woodbury, of whom we take pleasure in speaking as a skillful, careful, intelligent, and economical manager. Mr. Woodbury conducted the hatching of these eggs with great success, and closed his labors with putting into Clear Lake twenty-five thousand living and healthy young White Fish, from which we may reasonably hope to stock all the suitable waters in the State. It may be well to state that the great object at first is to get the desirable fish here and acclimated in our waters; after that they may be bred artificially and distributed to any extent.

It is probable, or at least possible, that ten thousand Shad may return to our waters this coming Spring and forty thousand more in 1876. If such should be the case and they are properly protected by legislation, it will be no difficult or costly matter to breed from them a million of young fish, which in three years more will stock the entire coast and give us Shad as plenty as we have Smelts. But to arrive at this we require some stronger legislation which will absolutely prevent the taking for food of the new Shad as they come in; we require them all for breeding.

If it shall be the pleasure of the Legislature to continue to aid this commission, it is our intention this next coming year to renew our

effort to bring across the continent the food fishes of the east, and with the experience which we have had and the additional knowledge we have gained, we have hopes of not only repairing our loss of last year but largely to improve upon that effort. We regret to say that our loss was large. We had embarked in it all the remaining funds of the commission, but no human foresight could have predicted it or guarded against it, and we can only say that it is worth all that it has cost to know the fact that an aquarium of living fish, eels and lobsters, provided with both fresh and salt water, can be brought from the Atlantic to within one day's travel of the Pacific, in good order and in healthy condition.

Since our last report the Commissioners have given somewhat of their attention to placing in some of the streams and lakes different kinds of native and other fish, although they have not been able to do so much as they would desire to do were the means at their command. There is no cheap way of doing this work; everything pertaining to it requires dispatch and care. We are handling a delicate and perishable material, under circumstances in which the painstaking and expense of the most careful preparations may, in a moment of neglect or accident, be lost entirely. Consequently, we have refrained from any expensive experiments, and confined ourselves to the introduction of food fishes fully known to be profitable in other States, and the dissemination of such domestic fish as can be easily and cheaply transferred from one part of the State to another. In this way we have, during the past season, placed some ten thousand Lake Tahoe trout in the South Yuba River; Trout from the mountain lakes have been placed in the north fork of the American River; we have purchased from the breeders of Tahoe Trout, also, six thousand Trout, which have been placed in Lake Merced. We have also purchased two thousand Eastern Red Speckled Trout—*Salmo fontanalis*—which we placed in the north fork of the American River, near the summit. Two thousand of the same and six thousand Tahoe Trout we have placed in the headwaters of Alameda Creek, and two thousand more Eastern Speckled Trout in San Andreas Reservoir, near this city.

The Commission feels greatly encouraged in its efforts to preserve and increase the fish of California by the general interest taken by the people in this very interesting subject. On all occasions we have had the most ready aid, and in many cases gratuitous services from those with whom the operations of the Commissioners have brought them in contact, and we would respectfully suggest that we believe that the people are now willing to incur a moderate expenditure in order to have this work continued. This Commission does not believe that any large appropriation for this purpose is now necessary. Time is required to develop and perfect the successful propagation and preservation of foreign varieties of fish. We have yet a great deal to learn in regard to this subject, and undue haste and lavish expenditure are by no means the most certain way to success. It is now three years since the first attempt to bring shad across the continent was commenced. We now know that some of the shad brought here in 1871 have lived and grown to good size. The shoal of shad are not due in the rivers of California until June, 1874, but we have had in our hands three specimens, which are, of course, exceptional, and we have heard

of two others. The incoming fish will be breeders, and we shall require funds to enable us to establish breeding stations on the Sacramento and San Joaquin rivers, and, above all, we require proper laws to preserve this season's arrivals. It will be seen by the accompanying statement that the entire expenditure of the Commission since its last report, has been less than six thousand dollars, and during the existence of the Commission—four years—but seven thousand. With this a great deal has been done, and the foundation laid for the accomplishment of much more.

The work is but commenced, and as we have before remarked time in this business is a more important element than money. The most in importance is the means for preventing the destruction of the fish we already have. The Commission find it almost impossible to prevail upon the people to refrain from destroying fish in the localities where they abound. It seems as if human invention is taxed to its utmost in the desire for wholesale destruction, and the reluctance which men feel to complain of their neighbors, renders it almost impossible to enforce the laws in such cases. If the Legislature should see fit to make an appropriation sufficient to allow the Commissioners to employ, at times, a proper person to look after such violations of the fish laws and see to their enforcement, we think this evil could readily be suppressed, as the people at large show a great interest in having the law enforced, but no one is willing to make himself obnoxious by being an informer. All this would be cured by placing the means of remedy in the hands of the Commission.

The Commission already have the power to do this, and have done it with most hopeful results, so far as their limited means have allowed. It will be necessary, during this session of the Legislature, to have passed a full and comprehensive law relating to all kinds of fishing. In the first place, the whole system of fish-traps, seins, fykes, etc., should be abolished by law. Secondly the meshes of the nets used should be regulated by law. The time of fishing for salmon should be properly limited. There come from all parts of the State constant complaints of the destruction of fish by saw-dust, and refuse from saw-mills thrown into the streams; and petitions for the enactment of laws to prevent it are now before the Legislature. This Commission will be aided by many citizens interested in these matters, in passing a law covering the piscatory interests of the State, which we hope will be favorably acted upon by the Legislature. The Commissioners have taken pains to ascertain the season of the year during which the taking of salmon should be prohibited by law. We have caused careful observations to be made of the time at which the salmon ascend to the heads of the rivers to spawn, and from all the information we have been able to obtain in that way, and by consulting with persons well qualified to afford advice from the results of practical knowledge of the subject, we would recommend that the taking of salmon be prohibited by law from the first of August to the first of November. It should be observed that the having in possession, or offering for sale, of salmon during the close term so prohibited, should be punished the same as of the taking of them.

In conclusion, your Commissioners, with much diffidence, would ask the aid of the Legislature for the means of carrying on the work

which they feel they have just commenced. There will be necessary for the coming season funds to erect hatching-houses at such stations as shall have been discovered as the spawning-grounds of the Shad, now soon to be expected in our waters. The renewal of our effort to bring the fish and lobsters across the continents, so nearly successful last year, is an earnest wish of the commission. Our work at large remains unfinished at the time that we are best qualified to prosecute it. The amount of appropriation necessary to carry the commission over to the next session of the Legislature is not large, and, when we consider the object to be attained, we feel that we may safely ask for a moderate sum without laying a very heavy additional burden upon the people. The money already expended is but a trifle compared with the benefits to be derived from a like expenditure in the immediate future.

When we entered upon the duties of our office the whole subject of fish-breeding had but lately been entertained on this coast. The ground was new, and the field of operations opened to the commission covered a large extent of country and marked varieties of climate. We have been compelled to educate ourselves to the work in hand, and to move as cautiously and as economically as possible. We are willing to admit that we take great interest in the continuance of our operations; we know that we have learned a great deal about fish culture that will be useful to the State. We believe that we are now on the road to success. We are willing to give our time to it, and perhaps it is not amiss for us to make this report the means of saying that, which may not be generally known, our services are without charge of any kind to the State. We have no individual interests to subserve, and we only ask aid from the State in order that we may serve her, and carry out to completion the objects for which this commission was created.

EXPENDITURES

At the last session of the Legislature an appropriation of two thousand dollars was made to aid the commissioners in prosecuting their work, and, since our last biennial report, we have expended the following amounts:

1873			
Jan.	25.	Paid for advertising in "Union"	$22 75
Jan.	25.	Paid copying Report	59 50
Jan.	27.	Paid Comer & Co. for Tahoe Trout For South Yuba	300 00
Mar.	17.	Paid telegraph	50
Apr.	19.	Paid expenses of establishing hatching station at Clear Lake, expense of hatching White Fish eggs, and examination of Clear Lake, Blue Lake, and other waters	547 26
May	3.	Paid Acclimatization Society for Speckled Trout placed in San Andreas Reservoir	100 00
May	5.	Paid Acclimatization Society for Speckled Trout placed in the tributaries of Alameda Creek	100 00
May	10.	Paid reward for the first Shad taken	50 00
June	3.	Paid traveling expenses of Commissioners	44 00
June	3.	Paid traveling expenses of R. H. Elam as Fish Warden, to Santa Cruz	60 00
June	3.	Paid Haight and Temple for legal services	50 00
June	3.	Paid Bugby for drawing for fish ladders	30 00
June	3.	Paid Cleveland for fitting up breeding troughs	77 28
June	3.	Paid T. H. Selby & Co. for lead pipe	38 09
June	12.	Paid Expenses of defending Salmon Laws	48 25
June	12.	Paid Acclimatization Society for Trout placed in American River	120 00
July	2.	Paid expenses of Commissioner to Sacramento to meet Shad	8 75
July	10.	Paid Comer and Frazer for Tahoe Trout placed in Lake Merced, 6000 in number	120 00
July	14.	Paid J. G. Woodbury for services, enforcing the Salmon Laws	104 50
July	14.	Paid Acclimatization Society for 6000 Tahoe Trout placed in Alameda Creek	120 00
July	14.	Paid expenses of placing the same	51 50
July	14.	Paid total expense of the Aquarium Car bringing fish, eels, and lobsters from the Atlantic Coast to California	*3,912 18
		Total amount expended	$5,845 56

* A part of this amount will be restored by a settlement now pending with the railroad companies.

RECAPITULATION

Amount of appropriation of 1870	$5,000.00
Amount of appropriation of 1872	2,000.00
Total	$7,000.00
Expenditures as per report of 1870 and 1871	$1,137.22
Expenditures as per report of 1872 and 1873	5,845.56
Cash remaining on hand Dec. 31, 1873	17.22
	$7,000.00

All of which is respectfully submitted.

S. R. THROCKMORTON,
B. B. REDDING,
J. D. FARWELL,
Commissioners.

APPENDIX

COMMISSIONERS ON FISHERIES

UNITED STATES

Prof. Spencer F. Baird.....Washington, D. C.

MAINE

E. M. Stilwell.....Bangor
Henry O. Stanley.....Dixfield

NEW HAMPSHIRE

Thomas E. Hatch.....Keene
William W. Fletcher.....Concord
W. A. Sanborn.....Wiers

VERMONT

M. C. Edmunds.....Weston
M. Goldsmith.....Rutland

MASSACHUSETTS

Theodore Lyman.....Brookline
E. A. Brackett.....Winchester
Asa French.....South Braintree

CONNECTICUT

William H. Hudson.....Hartford
Robert G. Pike.....Middleton
James A. Bill.....Lyme

RHODE ISLAND

Newton Dexter.....Providence
Alfred A. Reed, Jr.....Providence
John H. Barden.....Scituate

NEW YORK

Horatio Seymour.....Utica
Robert B. Roosevelt.....New York City
Edward M. Smith.....Rochester

NEW JERSEY

R. P. Howell.....Woodbury
J. H. Slack.....Bloomsbury

PENNSYLVANIA

H. J. Reeder.....Easton
B. L. Hewitt.....Holidaysburg
James Duffy.....Marietta

VIRGINIA

William B. Ball	Mid Lothian
Asa Wall	Winchester

ALABAMA

Charles S. G. Doster	Montgomery
Ro. Tyler	Montgomery
D. R. Hundley	Courtland

CALIFORNIA

B. B. Redding	Sacramento
S. R. Throckmorton	San Francisco
J. D. Farwell	San Francisco

MICHIGAN

Governor J. J. Bagley	Detroit
George H. Jerome	Niles
George Clark	Ecorse

OHIO

John Hussey	Loveland
John H. Klippart	Columbus
Dr. Elisha T. Stirling	Cleveland

CALIFORNIA FISH AND GAME

A publication devoted to the conservation of wild life and published quarterly by the California Division of Fish and Game.

The articles published in CALIFORNIA FISH AND GAME are not copyrighted and may be reproduced in other periodicals, provided due credit is given the California Division of Fish and Game. Editors of newspapers and periodicals are invited to make use of pertinent material.

All material for publication should be sent to Leo K. Wilson, Division of Fish and Game, 450 McAllister Street, San Francisco, California.

Vol. 19 APRIL, 1933 No. 2

THE TROUT NUMBER

In 1919, an especial "Trout Number" of CALIFORNIA FISH AND GAME was issued. So popular was that number with sportsmen and conservationists everywhere, that the reserve supply was soon exhausted and for many years this number has been out of print. During that time, a great many requests have come in for another "Trout Number."

Dr. J. O. Snyder, chief of the Bureau of Fish Culture, has contributed to this current issue a beautifully illustrated article on the trout of California. It is to be hoped that this contribution will be received with the same enthusiasm that greeted the first "Trout Number" of the journal.

There are few people interested in the field of conservation in California, who are not familiar with the work and ability of Dr. Snyder. During his long career as a man of science, he has compiled much of the data to be found in these pages and it is with pleasure that this "Trout Number" has been received from the author.

HUNTING ACCIDENTS, 1932

As has been the custom for several years past, statistics showing the number of hunting accidents in the State of California have been compiled by the Bureau of Education and Research. This information is secured by a careful perusal of newspaper clippings on such accidents which are sent to the division by a regular clipping bureau.

While these figures would indicate that fewer fatalities resulted from the annual shooting seasons, it will be found that the falling off in fatalities about corresponds to the decrease in the number of hunting licenses issued. No greater care is apparently being used by the hunter today than there was a few years ago.

It is regrettable that each open season witnesses this large number of preventable accidents. Only by proper care in the handling of firearms can this situation be remedied.

HUNTING ACCIDENTS, 1932

	1931	1932
Number of persons killed	60	32
Number of persons wounded, not killed	119	124
Number of self-inflicted accidents—	34	17
Fatal	64	64
Nonfatal		
Number of accidents inflicted by others—	15	12
Fatal	49	53
Nonfatal		
Number of accidents, cause unknown—	11	3
Fatal	6	7
Nonfatal		
Occurred while hunting large game (deer, bear, etc.)—	33	10
Fatal	36	26
Nonfatal		
Occurred while hunting small game (rabbits, duck, quail, etc.)—	16	12
Fatal	55	57
Nonfatal		
Occurred while hunting unknown game—	21	10
Fatal	28	41
Nonfatal		

1932 Figures Only

Occurred while hunting:	Fatal	Nonfatal
Ducks	6	13
Quail	1	6
Deer	8	25
Dove	2	11
Rabbit	1	18
Squirrels	--	3
Wild Boar	1	--
Goat	1	--
Bear	--	1

COMMERCIAL FISHERY NOTES

"FISH FOR FOOD"

A group of California business men has incorporated "Fish for Food" under the laws of this State for one million dollars. Offices are in Los Angeles. They recognize that the high food value and beneficial effects of sea foods are not fully appreciated in this country and that our per capita consumption of sea products is far below that of most other nations. They consider relatively high prices and inadequacy of retail outlets as two important conditions retarding the growth of our fresh fish trade. Quantity buying for cash and efficiency in handling are expected to reduce the price to the consumer.

A large retail organization is planned whereby standardized refrigerated show cases will be operated by trained employees. As in England, rabbits and poultry will be carried as side lines. One of several novel innovations planned is the issuance of a booklet for each kind of fish telling something of the fish, methods used in handling, and cooking recipes for the housewife.

THE PISMO CLAM IN 1932

In years gone by, the beaches of southern California, San Luis Obispo County and Monterey Bay were practically paved with Pismo clams (*Tivela stultorum*). But clammers dug faster than the clams could reproduce and now the Pismo clam is a rarity except at a few points on Monterey Bay where there are fair numbers and at Morro and Pismo beaches, where there are still enough to provide some reasonably good digging.

Because of the importance of the Pismo clam and because there are definite proofs of depletion, the California Division of Fish and Game has had considerable protective legislation enacted during the past twenty years. The most important laws provide for a maximum daily bag of 15 clams, a minimum size limit of 5 inches in length, a closed season from May 1 to August 31 on Monterey Bay, and a closed area or clam preserve at the south end of Pismo Beach. In addition, clams may not be held in possession outside of the shell nor may they be shipped, and all diggers must have commercial or sport fishing licenses. Although there is a constant patrol on Pismo Beach, complete enforcement of the laws is impossible because of a lack of cooperation from diggers and the general public. However, it is safe to say that if there were no protective laws and no game wardens, the clams would long since have disappeared from all our beaches.

Every year shows a decrease in the abundance of legal sized clams on Pismo Beach. Every year a larger proportion of the total clam population is composed of immature individuals. The diggers must depend more and more on the young clams. The present mortality rate of immature clams is alarming. During the spawning seasons of 1929, 1930 and 1931, there were excellent sets of young clams. These sets, following a series of poor spawnings, were counted on to replenish the depleted clam population. They were not given the chance. The first-year survival of 1929 clams was but 41 per cent; in other words, 41 per cent of the baby clams present on the beach in November, 1929, survived until the following November. No more than 38 per cent of the 1930 clams survived through 1931. The fate of the 1931 set, the best since 1919, was most tragic of all—less than 25 per cent of these clams remained on the beach in November, 1932. Previous to 1929, the first-year survival was always over 80 per cent. The second-year survival is now about 20 per cent of the original set, a dangerously low figure when it is noted that the second-year survival was always above 50 per cent prior to 1929. At the present rate of depletion it is hard to see how any significant numbers of 1929–1931 clams can survive to 4 or 5 years, the ages at which most Pismo clams start spawning in earnest. (Some Pismo clams produce a relatively small amount of spawn at 3 years of age.) The 1932 spawning season proved to be unsuccessful and can furnish no appreciable numbers of small clams. The future rests almost entirely with the remnants of the 1929–1931 groups.

The above figures refer only to the "open" part of the beach. The situation is much better in the closed area. Although the sets are not as heavy at this end of the beach, the survival has been much better since the creation of this district. For example, the 1931 set had a first-year survival of 61 per cent in the closed area as against 24 per cent in the open district. Although the closed area set of 1931 was not half as good as it was on the remainder of the beach, there were more clams surviving through 1932 south of the boundary than in an equal extent of the open beach. It is to be hoped that the closed area will provide an adult spawning population that will eventually restock the entire beach.—Richard S. Croker, California State Fisheries Laboratory, January 25, 1933.

FISHERIES RESEARCH IN RUSSIA

As part of Russia's five-year plan, an intensive nation-wide scientific survey was inaugurated. The progressive Russian government realized the importance of ascertaining the extent of the nation's natural resources and determining how they could be used to the best advantage. Expeditions were sent to all corners of the far-flung Union to study everything of scientific interest—geology, fisheries, botany, physics, forestry, astronomy, mammalogy, geography, ornithology, and others. Concrete results in the form of expanded industries are already manifest.

A great deal of work has been done in the field of fisheries. There are four main institutes for fisheries research, correlating the activities of a network of smaller laboratories on the Aral, Baltic, Black, Caspian and Murman seas, the Pacific Ocean, and inland lakes and rivers. There are about 500 scientists and 1000 other workers engaged in fisheries work throughout the Union. All aspects of the fisheries are studied to the end that the fishing industry can expand profitably without endangering the supply of fish. Experts have been sent abroad to study foreign fishing methods, conservation work and fisheries administration. Several Russian scientists have visited the California Division of Fish and Game and the State Fisheries Laboratory in their quest for information. As a result of studies at home and abroad the fisheries department has introduced new methods of fishing and has opened up previously unknown fishing grounds to the extent that the Russian fishing industry has almost doubled in importance during the last few years with no apparent threat to the supply of fish.—Richard S. Croker, California State Fisheries Laboratory, March 3, 1933.

RARE WHALE TAKEN AT SAN PEDRO

On February 4, 1933, a carpenter employed at a local boat works saw a small whale inside Los Angeles Harbor. It appeared to be feeding on schools of small fish and was so preoccupied that he was able to get close enough in a skiff to lasso it around the tail. For some time he was in the same predicament as the man who grabbed the bear by the tail, but finally the whale, in one of its wild dashes, beached itself and ended the struggle. It was a female, 10 feet 10 inches long and weighed 750 pounds.

The whale proved to be a species described in 1874 as new by Charles M. Scammon (The marine mammals of the northwestern coast of North America. San Francisco, Carmony, 1874), and only recorded a few times since. Probably this Pacific species (*Balaenoptera davidsoni*) named by Scammon will prove to be identical with *B. acutorostrata* (Lac.) of the North Atlantic. These whales are referred to as sharp-headed finners in the Pacific and little piked whales in the Atlantic. They normally reach a length of 25–30 feet so the one taken here was obviously very young.—D. H. Fry, Jr., California State Fisheries Laboratory, March 3, 1933.

DIVISION ACTIVITIES

BUREAU OF FINANCE

For the past calendar year the revenues from fishing and hunting licenses and deer tags showed a decrease of some $200,000 over that received during the preceding year. However, there seems to be a brisk business in angling licenses, for during January over $100,000 such licenses were sold. The only fish available for legal catching now are striped bass and steelhead, with black bass in some areas.

Those subagents handling fish and game licenses have expedited the work of the Bureau by speeding their returns and reports, and but few exceptions are noted. County clerks have given splendid cooperation in closing their accounts for the year.

As a result of the granting of additional tonnage of sardines for reduction purposes the income from this industry held up well during the sardine season. Fines, however, showed a strong decline for the last half of 1932.

BUREAU OF FISH CULTURE

While the heavy snow storms of December and January did not cause the damage and inconvenience that they did a year ago, some of the hatcheries in the higher elevations were snowed in. Roads were closed in several instances and snowshoes and skis were necessary to get supplies and mail to the hatchery help.

Gathering of trout eggs has been going on with splendid results. The "take" for January was 2,934,243 trout and 614,476 salmon, making for the present season over 21,000,000 trout and some 6,400,000 salmon eggs taken to the hatcheries. Many of these eggs have already been hatched and the fry are being developed for later planting.

The past year was noted for the heavy distribution of trout and salmon. From the 28 hatcheries 36,889,689 of the former species of fish were put in streams and lakes of the State, and over 18,000,000 salmon were released in the Klamath and Sacramento rivers.

The merging of several hatcheries in southern California with the newly acquired Forest Home plant has been accomplished, and estimates are that more fish will be raised in this large plant than in all the others combined. Beside increasing production, this merger reduced overhead considerably.

The first of the small-mouth black bass raised in the Friant experimental ponds to be planted in other waters was carried on during the past few weeks. More than 1000 four-and-a-half fingerlings were taken to Kercohkoff Lake and turned loose. Fresno Associated Sportsmen assisted in the transfer and will aid in their care in the new environment.

BUREAU OF FISH RESCUE AND RECLAMATION

The year 1932 was one that found this Bureau saving over five million sport fish in various areas of the State. Had it not been for the work of this department these fish would have been an absolute loss, whereas now they are to be found in many streams and lakes, ready for the angler.

The saving of over 33,000 striped bass swept into unsuitable areas by irrigation ditches was a feature of the work of the Bureau during the year. Some 31,000 of these great sport fish were taken from one irrigation system in the San Joaquin Valley.

During the year 2,781,111 large-mouth black bass were rescued and over 1,000,000 perch saved from destruction.

BUREAU OF PATROL

During the early part of the year, there was a perceptible dropping off in the number of arrests and fines as compared with the same period during 1932. Difficulty was experienced in several sections where violators were dismissed by trial judges upon entering pleas of necessity to justify their actions in taking game illegally. The situation has been particularly critical in dealing with the Indian populations in isolated sections. In none of the cases checked, however, could any real destitute conditions, as far as Indians were concerned, be discovered, and in some instances they were in much better condition to take care of themselves than the poor white residents in the same sections.

The campaign against the sale of ducks was carried on throughout this period and was maintained by means of an undercover squadron until the bulk of the waterfowl population migrated north to their nesting grounds. Because of the economic situation, many people who have not been doing illegal hunting for years have turned to this pursuit as a means of livelihood.

VOLUNTEER DEPUTIES

This body of men who give of their time to aid in the enforcement of the fish and game laws, while not having a record of accomplishments during the past year as they did in 1931, owing to the force being cut from 550 to 250 men, carried on their work with good effect.

During the past year, beside aiding in law enforcement, checking over 30,000 hunting and angling licenses, they destroyed over 3000 predatory animals, birds and snakes.

Where there was a heavy fall of snow this winter the volunteer deputies have been active in feeding quail with grain furnished by the Commission and Sportsmen's clubs. In this work they have done much to save from starvation many coveys of quail.

Four more sanctuaries, in the Terra Bella Irrigation District, Tulare County were established. Several hundred acres were set aside for the propagation of this game bird.

BUREAU OF HYDRAULICS

With but few exceptions, oil pollution of State waters has been of a negligible quantity during the past few months. Those companies that permitted oil to escape cooperated to the utmost in remedying the condition.

The Los Angeles Flood Control has installed fish screens in outlets from the San Anita dam. Screen installation in canals of the Los Angeles Water Company located in Inyo County have been discussed

and proper protective measures will be taken to conserve the fish that inhabit the source of the city's waters.

The Pacific Gas and Electric Company is lending every assistance in protecting deer along their conduits in Amador County. They have erected several miles of 7-foot fence along their canals, with bridges at proper points. As occasions arise further fencing will be done. As a result of the work already completed the loss of deer from falling in the waterways has fallen off to practically nothing.

BUREAU OF GAME REFUGES

Water fowl have found the four State owned refuges excellent resting places during the past season. So well pleased have they been with conditions that countless numbers are congregating on each of the refuges, and indications are that more will remain permanently than has been noted for years. Efforts to convince ducks and geese that this is a good State to live in and raise families will be carried on by supplying proper feed. In some of the refuges grain will be planted and experimental work along these lines followed out, at but little expense.

It is believed the water levels on the Salton refuge will have to be raised by building levees, that the tule growth may be controlled. At Gridley the tule question has become a serious one.

Trappers and others have made it tough for predatory animals and birds. During the year 1932, 325 mountain lions were killed on which bounties averaging $25 a head were paid. Already this year the record for January is 28, equal to the average of the past 20 years for the first month of the year.

In addition, during January, 39 coyotes and 17 wild cats were trapped and destroyed on the water fowl refuges.

Game breeders do not seem to be so numerous this year. The number of licenses renewed for this year total 210 out of 389 issued last year.

BUREAU OF GAME FARMS

Usually January is not noted for the distribution of game birds from the State game farms, but this year some 1100 were sent from Yountville and Chino. The upland birds released on protected areas were mostly quail, though pheasant were distributed in several counties.

Returns from eggs sent to private hatcheries and those operated under the direction of sportsmen's clubs show that close to 5000 pheasants were hatched during the past year, a substantial gain over the year before.

Cold weather at Yountville in December damaged the cover crop some, and heavy winds in southern California unroofed barns and other buildings at Chino. Some quail and partridges got loose during the storm, but all were trapped and returned to their pens.

Trappers on the new quail refuges in southern California are killing many predators, and this line of endeavor will be pursued to the utmost during this year.

Everything is in readiness for the spring egg laying season of upland birds, and the same policy of sending out eggs and 12-week old birds to responsible parties will be continued.

BUREAU OF COMMERCIAL FISHERIES

The sardine season closed this year on February 15 in the Monterey district, while the San Pedro area continued on to March 1.

Owing to the permits issued for a greater number of tons for reduction purposes this year the canneries handled a larger tonnage of sardines than they did last season. The number of cases packed, both in the south and north were much less than for 1932.

A request by the Monterey canners for an extension of two weeks of the present season on sardines was denied by the members of the Commission at a public hearing held in San Francisco.

The floating reduction plants handled up to February 1 over 55,000 tons of sardines.

Sardine canners at San Pedro are fostering a move to have the 50 cents per ton tax reduced, and this question will be presented for further consideration.

Tuna canning at San Pedro and San Diego enjoyed a profitable year during 1932. The pack was some 15,000,000 pounds more than in 1931, and it is said the plants enjoyed a good demand for their products.

H. C. Godsil of the State Fisheries Laboratories is conducting a study of purse seine boats, and the damage they are purported by larger tuna fishing boat owners to wreck on young yellowfin.

Considerable activity is being manifest in regards the oyster industry. At Eureka a meeting attended by representatives of the State Chamber of Commerce, the local chamber of commerce, N. B. Scofield, H. C. McMillan of the U. S. Bureau of Fisheries, and Paul Bonnot of this Bureau, discussed oyster culture generally and in Humboldt Bay in particular. A bill designed to regulate this industry and which was drawn by Scofield, Bonnot and McMillan was given especial attention.

At Mad River two companies are spending a considerable sum of money on buildings, boats, floats and dikes on oyster development work.

Five bulletins, dealing with sharks, sardines, mackerel and striped bass are completed and ready for publication during this year.

BUREAU OF EDUCATION AND RESEARCH

Much of the activity of this bureau was centered around the legislative work being done in Sacramento. Special reports covering various game species were prepared for the use of the legislators and during this time, the biennial report was brought forth from the printer in time to be distributed to those in Sacramento interested in the work of the division.

Special meetings were held with interested sportsmen in various sections of the State in order to get a cross section of opinion from these different localities. From these meetings, a better insight into conditions was had than existed prior to that time.

Publicity was afforded through regular programs over radio stations KFRC, in San Francisco, and KHJ, in Los Angeles. These weekly broadcasts gave up-to-the-minute information on hunting and fishing conditions throughout the State.

Many volumes have been added to the library, most of them comprising reports of research work in game fields in other States, and these have been in constant use by the employees of the division.

Outbreaks of deer disease have required almost constant attention on the part of our pathologist for the division and it is to be hoped that eventually the losses from this source can be reduced to a minimum.

The third annual census of black sea brant was taken during the month of February and the results of this work will be published in an early number of CALIFORNIA FISH AND GAME.

STATEMENT OF INCOME

For the Period July 1, 1932, to December 31, 1932, of the Eighty-fourth Fiscal Year

Departmental income	Detail	Total
License sales:		
Angling licenses, 1931	$927 00	
Angling licenses, 1932	173,090 00	
Angling licenses, 1933	37 00	
Commercial Hunting Club licenses, 1932-33	2,075 00	
Commercial Hunting Club Operators licenses, 1932-33	565 00	
Deer tags, 1932	90,809 00	
Fish Breeders' licenses, 1932	40 00	
Fish Importers' licenses, 1932	10 00	
Game Breeders' licenses, 1932	95 00	
Game Breeders' licenses, 1933	2 50	
Hunting licenses, 1931	208 20	
Hunting licenses, 1932-33	233,640 50	
Kelp licenses, 1932	30 00	
Market Fishermen's licenses, 1932-33	21,310 00	
Trapping licenses, 1932-33	1,170 00	
Wholesale Fish Packers' and Shell Fish Dealers' licenses, 1932-33	815 00	
Total license sales		$525,424 20
Other income:		
Contributions from importers	$170 00	
Court fines	18,051 99	
Fish packers' tax	42,191 20	
Fish tag sales	1,406 95	
Game tag sales	94 59	
Interest on bank balances	3,657 13	
Kelp tax	3 02	
Lease of kelp beds	1,025 60	
Miscellaneous sales	12 00	
Publication sales	387 60	
Total other income		67,600 08
Total departmental income		$593,024 28
Income for the State University fund:		
Kelp tax		$1 50

STATEMENT OF EXPENDITURES

For the Period July 1, 1932, to December 31, 1932, of the Eighty-fourth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Administration:					
Executive	$4,700 01				$4,700 01
Clerical and office	10,847 41	$154 68	$264 70	$140 70	11,707 49
Printing		2,301 12			2,301 12
Automobiles		127 16	194 81	1,029 00	1,350 97
Traveling			1,655 80		1,655 80
Postage			2,382 65		2,382 65
Telephone and telegraph			1,646 11		1,646 11
Freight, cartage and express			1,380 09		1,380 09
Rent			7,904 09		7,904 09
Accident and death claims			1,125 20		1,125 20
Accounting pro rata	2,250 00				2,250 00
Legal	1,800 00		56 30	101 40	1,957 70
Premiums on bonds			118 52		118 52
Publicity			14 02		14 02
Total administration	$19,597 42	$2,882 96	$16,742 29	$1,271 10	$40,493 77
Education and research:					
Chief and assistants	$1,950 00				$1,950 00
Clerical and office	960 00	$29 93	$59 78		1,049 71
Traveling			1,366 44		1,366 44
Photographer			69 04	$215 03	284 07
Librarian	1,020 00	12 93	39 38	67 47	1,139 78
Research	3,300 00	26 44			3,326 44
Publicity	1,800 00		23 62		1,823 62
Lecturer	1,050 00				1,050 00
Total education and research	$10,080 00	$69 30	$1,558 86	$282 50	$11,990 66
Patrol and law enforcement:					
Chief and assistants	$5,550 00				$5,550 00
Clerical and office	1,590 00	$17 80	$1 28		1,609 08
Automobiles		6,318 69	3,517 08	$4,405 08	14,241 75
Traveling			46,107 78		46,107 78
Postage			309 92		309 92
Telephone and telegraph			798 40		798 40
Freight, cartage and express			14 45		14 45
Rent			179 00		179 00
Heat, light and power			4 57		4 57
Captains and deputies	100,507 00	299 25	219 87	41 01	101,067 13
Launches		704 63	1,054 98		1,759 61
Fish planting	2,310 00	229 64	720 05	137 50	3,397 19
Premiums on bonds			1,787 56		1,787 56
Statistical			168 00		168 00
Temporary help	89 34				89 34
Cooks	750 00				750 00
Commercial fisheries patrol:					
Chief and assistants	1,380 00				1,380 00
Captains and wardens	8,280 00	4 65	27 15		8,311 80
Launches	6,032 00	1,632 79	341 81	63 92	8,070 52
Fish cannery inspectors—seasonal	7,752 11				7,752 11
Travel			4,049 46		4,049 46
Rent			335 00		335 00
Automobiles		105 40	21 93		127 33
Temporary help	253 34				253 34
Total patrol and law enforcement	$134,493 79	$9,312 85	$59,659 28	$4,647 51	$208,113 43
Commercial fisheries:					
Chief and assistants	$6,810 00				$6,810 00
Clerical and office	4,800 00	$41 94	$44 25		4,886 19
Automobiles		124 41	72 58		196 99
Traveling			3,560 39		3,560 39
Postage			75		75
Telephone and telegraph			274 85		274 85
Freight, cartage and express			180 89		180 89
Rent			237 52		237 52
Heat, light and power			138 82		138 82
Research	1,937 84	26 62		21 23	1,985 69
Launches				1,386 00	1,386 00
Laboratory	12,959 80	260 42	438 39	200 52	13,859 13
Hydro-biological survey, Monterey Bay			750 00		750 00
Statistics		272 83	792 66	305 00	1,370 49
Fish cannery research			2,500 00		2,500 00
Total commercial fisheries	$26,507 64	$726 22	$8,991 10	$1,912 75	$38,137 71

STATEMENT OF EXPENDITURES—Continued

For the Period July 1, 1932, to December 31, 1932, of the Eighty-fourth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Fish culture:					
Chief and assistants	$5,580 00	$2 00			$5,582 00
Clerical and office	2,040 00	6 02	$21 63	$5 97	2,073 62
Automobiles		3,209 51	1,505 24	1,223 89	5,938 64
Traveling			6,973 43		6,973 43
Postage			80 76		80 76
Telephone and telegraph			592 97		592 97
Freight, cartage and express			294 65		294 65
Rent			1,115 75		1,115 75
Heat, light and power			665 54		665 54
Hatcheries	60,035 33	43,975 00	1,405 85	980 65	106,486 83
Special field investigations	3,460 00		5 25	7 13	3,492 38
Fish cars	1,770 00	258 39	704 81		2,733 20
Blue printing			11 36		11 36
Cooperative research	1,650 00	194 60	1,247 01	791 10	3,882 71
Temporary help	1,278 00				1,278 00
Fish hatchery assistant—seasonal	15,071 77				15,071 77
Total fish culture	$90,905 10	$47,645 52	$14,714 25	$3,008 74	$156,273 61
Hydraulics:					
Chief and assistants	$4,170 00				$4,170 00
Clerical and office		$11 47	$37 30	$39 60	91 37
Automobiles		204 82	93 14	563 88	861 84
Traveling			820 25		820 25
Postage			2 00		2 00
Telephone and telegraph			2 10		2 10
Total hydraulics	$4,170 00	$219 29	$954 79	$603 48	$5,947 56
Game propagation:					
Superintendents	$1,650 00				$1,650 00
Automobiles		$521 34	$197 63		718 97
Traveling			2,257 93		2,257 93
Postage			14 62		14 62
Telephone and telegraph			134 96		134 96
Freight, cartage and express			12 60		12 60
Heat, light and power			631 56		631 56
Rent			15 00		15 00
Maintenance	6,300 00	4,667 09	382 13	$28 00	11,377 22
Temporary help	1,538 00				1,538 00
Quail trapping and expansion of quail program	3,451 39	293 28		5 95	3,750 62
Total game propagation	$12,939 39	$5,481 71	$3,646 43	$33 95	$22,101 48
Fish rescue:					
Chief and assistants	$2,400 00	$31 00	$9 00		$2,440 00
Traveling			916 94		916 94
Rent			110 00		110 00
Temporary help	88 50				88 50
Total fish rescue	$2,488 50	$31 00	$1,035 94		$3,555 44
Game refuge:					
Chief and assistants	$4,249 98				$4,249 98
Clerical and office	960 00	$41 40	$27 40		1,028 80
Automobiles		375 55	127 53	$600 00	1,103 08
Traveling			2,142 72		2,142 72
Telephone and telegraph			90		90
Lion hunters and trappers	4,321 00				4,321 00
Refuge posting	360 00	7 84			367 84
Predatory animal control			3,200 00		3,200 00
Temporary help	3,938 71				3,938 71
Refuge maintenance	3,330 00	908 26	1,327 13		5,565 39
Predatory animal hunters and trappers—seasonal	4,795 00				4,795 00
Fences				6,502 73	6,502 73
Total game refuge	$21,954 69	$1,333 05	$6,825 68	$7,102 73	$37,216 15

STATEMENT OF EXPENDITURES—Continued

For the Period July 1, 1932, to December 31, 1932, of the Eighty-fourth Fiscal Year

Function	Property and equipment	Total
Construction, improvements and equipment:		
Bass ponds	$832 91	
General repairs, improvements and construction of cottage at the Brookdale Hatchery	1,648 76	
Lake Elinor Egg Collecting Station	231 12	
Tank and Egg Collecting Station at Huntington Lake	77 74	
Kaweah Garage Project	169 78	
Klamathon Station—Station House and Dry Room Project	310 64	
Klamathon Station—Warehouse Project	156 00	
Kosk Creek Egg Collecting Station	219 30	
Repairs and improvements at Mt. Shasta Hatchery	229 95	
Maintenance and improvements, Navarro River Jetty	33 79	
Opening Salinas River Channel	52 35	
Sebastopol Bass Rearing Ponds	351 88	
Total construction, improvements and equipment		$4,314 22
License commissions		$20,310 06
Purchase of game refuges		33,409 19
State Fair and other exhibits		1,291 97
Prior year expense—83d fiscal year		9,802 52
Prior year expense—82d fiscal year		5 90
Deer tight fences—Chap. 872-31		1,533 60
Electro Metals Company's claim—Chap. 599-1931		18,750 00
Grand total, proprietary group		$619,247 27

GAME CASES

October, November, December, 1932

Offense	Number arrests	Fines imposed	Jail sentences (days)
Deer; closed season; killing does; no tags; killing spike buck	83	$1,313 00	949½
Illegal shooting blinds	2	40 00	
Doves; closed season	4	85 00	
Ducks; geese; mudhens; overlimit; closed season	24	325 00	762
Commercial Gun Club License Act; violations of	13	138 00	
Hunting License Act; violations of	76	1,477 00	163
Hunting in refuge	29	357 00	41
Mountain sheep; killing of	1	100 00	
Night hunting	21	640 00	
Nongame birds; killing of	14	495 00	
Pheasants; killing of	9	335 00	20
Pigeons; closed season	6	137 50	
Quail; closed season; overlimit	14	230 00	
Rabbits; closed season	3	40 00	
Tree squirrels; closed season	2	50 00	
Shooting from auto; powerboat	6	200 00	
Sage hens; closed season	2	75 00	
Shorebirds; closed season	10	160 00	
Trespassing	26	180 00	
Trapping License Act; violations of	6	40 00	2½
Trapping game birds	2		360
Illegal shipping of game birds	1	25 00	
Totals	354	$6,442 50	2,298

FISH CASES

October, November, December, 1932

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalones; small; overlimit	21	$325 00	
Angling License Act; violations of	52	573 00	65
Barracuda; small	1	25 00	
Bass—striped; small	7	120 00	
Bass—black; small	1	20 00	
Clams; small; overlimit	48	525 00	130
Crabs; female and small	4	50 00	5
Commercial Fishing License Act; violations of	22	165 00	
Lobsters; small	48	810 00	0
Using explosives to kill fish	1		
Night fishing	4	10 00	10
Spearing fish	13	25 00	147½
Salmon; overlimit	9	75 00	200
Seines; nets; illegal use of	4	225 00	
Steelhead; overlimit	8	135 00	
Fishing near fishway or dam	3	75 00	
Obstructing stream	5		
Totals	251	$3,158 00	556½

SEIZURES OF FISH AND GAME

October, November, December, 1932

Fish:	
Abalones, pounds	799
Barracuda, pounds	1,200
Bass—	
Black	5
Striped	24
Striped, pounds	372
Clams	1,230
Crabs	918
Catfish	438
Halibut	4
Lobsters, pounds	3,290
Salmon, pounds	504
Skipjack, pounds	6,719
Yellowfin tuna, pounds	3,753
Steelhead trout, pounds	1,671
Traps, fish	72
Sheephead, pounds	51
	16
Game:	1,025
Deer	7
Deer meat, pounds	855
Doves	1
Ducks, geese, mudhens	21
Mountain sheep	13
Nongame birds	11
Pheasants	82
Pigeons	2
Quail	1
Rabbits	17
Squirrel, tree	1
Shorebirds	
Sagehen	

CALIFORNIA FRESH FISHERY PRODUCTS FOR THE MONTHS OF OCTOBER, NOVEMBER AND DECEMBER, 1932

Compiled by Division of Fish and Game, Bureau of Commercial Fisheries

Species of fish	Del Norte, Humboldt	Mendocino, Sonoma, Lake	Marin	Solano, Yolo	Sacramento, San Joaquin	Alameda, Contra Costa	San Francisco, San Mateo	Santa Cruz	Monterey
Albacore								45,076	367,041
Anchovy							16,045		5,155
Barracuda								10	30
Bonito									
Cabrilla									
Carp		4,328			610	530			
Catfish				1,115	52,892	48,063			
Cultus	45,255	22,044	75				69,448	4,868	30,147
Flounder	1,955	895					53,317	1,204	841
Flying fish									
Hake	1,925	2,170					1,438		
Halfmoon									
Halibut—California			36				250	1,463	1,497
Halibut—Northern	26,945	1,358					1,916		
Hardhead		22,707			2,422				
Herring	417		179,790				33,605		
Kelp Bass									
Kingfish		297					691	521	22,247
Mackerel—Horse									22,729
Mackerel—Pacific		35					1,050	253	136,693
Mackerel—Spanish									
Mullet									
Perch	840	377	12,823				8,652	140	1,545
Pike					17	126			
Pompano									
Ray									
Rock Bass									
Rockfish	54,531	30,098					142,917	206,916	235,903
Sablefish	101,002	22,169					6,564	76,688	2,465
Salmon	41,355			24	341	111			
Sand Dab	25,842	17,353					89,037	1,440	1,632
Sardine							20,932,770	110	94,990,066

Sculpin							460	78	
Sea Bass—Black									
Sea Bass—White			4,032				534	10	3,022
Shad					16	12			
Shark	1,550	525					30,875	1,080	
Sheepshead									
Skate	2,020	3,523					36,078	1,410	2,577
Skipjack									
Smelt	12,448	458	9,458			177	20,628	9,116	47,372
Smelt—Jack	482	9	4,180					1,433	
Sole	535,225	271,853					1,091,001	24,244	7,580
Splittail					630	2,000			
Striped Bass			70	1,757	27,548	93 700	4		
Sucker		3,785			147				
Swordfish—Broadbill									
Swordfish—Marlin									
Tom Cod	2,138								
Tuna—Bluefin									
Tuna—Yellowfin									
Turbot		501	4				7,502		
Whitebait	10	444					11,925		495
Whitefish									
Yellowtail									
Miscellaneous	20,824	1,353					5,212	170	507
Total fish	887,070	415,282	210,468	2,806	84,623	144,818	22,562,819	377,139	95,870,544
Crustaceans:									
Crab	7,056	1,188					611,136	22,692	1,444
Shrimp			146,783			93,488	111,797		577
Spiny Lobster									
Mollusks:									375,000
Abalone		97						54	
Clam—Hardshell		525	20,042						
Clam—Mixed	5,881	1,234						1,669	9,713
Clam—Pismo						2,510	486		
Clam—Softshell	600	311	33,771						
Mussel							84		294
Octopus		1,246					75,871		
Oyster—Eastern			40,924				8,208		9,142
Oyster—Native								120	139,513
Squid									
Miscellaneous:									
Turtle									
Totals	901,297	419,883	451,988	2,806	84,623	245,825	23,370,491	401,674	96,415,227

All amounts shown in pounds unless otherwise specified. Skipjack and Albacore cleaned.

CALIFORNIA FRESH FISHERY PRODUCTS FOR THE MONTHS OF OCTOBER, NOVEMBER AND DECEMBER, 1932—Continued

Compiled by Division of Fish and Game, Bureau of Commercial Fisheries

Species of fish	San Luis Obispo, Santa Barbara, Ventura	Los Angeles	Orange	San Diego, Imperial	Total	Fish from south of the International Boundary brought into San Pedro	Fish from south of the International Boundary brought into San Diego	Total fish from south of the International Boundary brought into California
Albacore		12,835			425,852			
Anchovy		510			21,710			
Barracuda	3,014	219,403	391	11,911	234,759	72,163	11,225	83,388
Bonito	157	322,087	1,008	3,071	327,013	237,914	9,846	247,760
Cabrilla						34,725	50,387	85,112
Carp					5,468			
Catfish					102,070			
Cultus	60	193	502		172,592			
Flounder	9	736	13	13	58,083			
Flying fish		400			400			
Hake		412			5,045			
Halfmoon		8,888			8,888			
Halibut—California	64,715	117,277	15,517	6,391	207,146	934	85	1,019
Halibut—Northern					30,219			
Hardhead					25,120			
Herring				9,784	223,596			
Kelp Bass		2,392			2,392			
Kingfish		81,352	485	595	106,188			
Mackerel—Horse		80,209			108,038			
Mackerel—Pacific	1,726	3,274,612	52,543	50,000	3,516,012			
Mackerel—Spanish						1,019	2,913	3,932
Mullet			103	443	546			
Perch	597	4,546	12		29,532			
Pike					143			
Pompano		55			55		348	348
Ray		547	4		551			
Rock Bass	1,719	52,244	6,761	27,421	88,145	1,130	470	1,600
Rockfish	15,392	289,983	4,054	135,957	1,124,751		3,684	3,684
Sablefish	6	19,230	3,070		234,203			
Salmon					41,831			
Sand Dab	2	1,107	219		136,722			
Sardine	420	65,508,299		1,061	181,522,726		66	66
Sculpin	30	13,499	1,448	3,490	19,005			

Sea Bass—Black	869	3,083	6,910	15,985	26,847	46,644	26,281	72,925
Sea Bass—White	8,560	120,338	114	12,208	148,017	27,916	34,055	61,971
Shad					28			
Shark	456	44,509	38,517	11,583	129,095		118	118
Sheepshead	10,091	17,979	3,753	5,573	38,296			
Skate		9,094	909		56,511			
Skipjack		728	84	1,601	2,413	815,677	2,021,046	2,836,723
Smelt	1,145	68,638	30,623	6,812	206,875			
Smelt—Jack	37	1,240		42	7,423			
Sole	61,851	17,712	19	334	2,010,719			
Splittail					2,630			
Striped Bass					123,178			
Sucker					3,032			
Swordfish—Broadbill	972	118,436	5,202	87,745	212,445	7,508	354	7,862
Swordfish—Marlin	170	6,689	158	1,464	8,481			
Tom Cod					2,138			
Tuna—Bluefin		741			741			
Tuna—Yellowfin				366	366	2,303,212	6,457,946	8,761,158
Turbot			9		8,016			
Whitebait					12,880			
Whitefish	153	13,631		20,230	34,014	218	5,459	5,677
Yellowtail	260	20,471		62,640	92,371	244,267	145,963	390,230
Miscellaneous		7,418	293	317	45,094		130	130
Total fish	173,311	70,567,222	172,901	477,127	191,955,820	3,793,327	8,770,376	12,563,703
Crustaceans:								
Crab		129			643,645			
Shrimp					357,645			
Spiny Lobster	84,412	01,540	13,826	41,903	231,681	4,104	114,751	118,855
Mollusks:								
Abalone	142,800	42			517,939			
Clam—Hardshell		5,676			26,297			
Clam—Mixed					7,115			
Clam—Pismo	18,476				29,858			
Clam—Softshell					37,777			
Mussel			50		50			
Octopus		88	59	09	1,840			
Oyster—Eastern					116,705			
Oyster—Native					17,440			
Squid		320	24	115	140,002			
Miscellaneous:								
Turtle							80	80
Totals	418,099	70,665,017	186,860	519,214	194,083,994	3,797,431	8,885,207	12,682,638

ABSTRACT
CALIFORNIA SPORTING FISH AND GAME LAWS
VALID UNTIL 90 DAYS AFTER CLOSE OF 1933 LEGISLATURE

1931 OPEN AND CLOSED SEASONS 1932

WHITE SQUARES INDICATE OPEN SEASON. NUMBERS IN SQUARES ARE OPEN DATES

GAME	DISTRICTS	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	BAG AND POSSESSION LIMITS, ETC.
DEER	1½										15			No Does, Fawns or Spike Bucks No Forked Horned Deer In Dist. 1M No sale of Venison or Deer Skins Two Bucks per Season except in 1¾ where limit is one See Notes 6-9-10-12
	2-2¼-3								14					
	1-1¼-4-4¼-4½-23-24-25								16	15				
Rabbits—Cottontail and Brush	ALL EXCEPT 4¾											15	15	15 per day. 30 per week. No limit in District 4 No protection in 4¾
Bear, Fur Animals	ALL											15		See Note 7 Predatory animals unrestricted in districts 2-2¼-3-4-4¾
Ducks, Geese, Jack Snipe, Mud Hens	ALL — FEDERAL LAW										25 DUCKS 5 GEESE OCT. 1			15 Ducks, 30 in Possession; 4 Geese, 8 in Possession; 20 Snipe, 25 Mud Hens, No Ross Snow or Cackling Geese
	ALL — STATE LAW	15												25 Ducks, 25 Snipe, 25 Mud Hens; 50 Per Week Goose limit See Note 4. See Notes 9-10-11-12-13
Quail—Valley, Desert and Mountain	ALL EXCEPT 1¼											15	15	Valley and Desert 15 per day. 30 per week Mountain 10 per day. 20 per week
	1¼													
Dove	ALL EXCEPT 4-4½-4¾													Federal Season Open Date September 1 — 15 per day; 30 per week
	4-4½-4¾													

There is no open season on Elk, Antelope, Mountain Sheep, Sea Otter, Tree Squirrel, Sierra Hare, Rail, Wood Duck, Pigeon, Swan, Shore Birds (except Jack Snipe), Grouse, Sage Hen, Imported Quail, Wild Pheasant, Partridge, or Wild Turkey.

FISH	DISTRICTS	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	BAG AND POSSESSION LIMITS, ETC.
Steelhead and all Trout (except Golden), Whitefish Unlawful to take trout in waters closed by Governor's proclamation	1-1¼-1¾-2-2¼-3-4½-4¾-15 Klamath River, Lake Almanor													Bag limit for taking and possession, 25 trout or 10 pounds and one trout. — No Sale No Spearing For other restrictions See Notes 12-15-16-20 21-22-28-29 31-33 On this Card
	2½		28			30								
	23-24-25					30								
	Truckee River					15								
	See Note 22													
	1½ Winter Klamath River													5 Trout regardless of weight
	Siskiyou, Modoc, Lassen and Del Norte Counties, 2-3-15													3 Trout regardless of weight
Golden Trout	ALL													20 per day. None under 5 inches Not more than 10 lbs. and one
BLACK BASS	ALL EXCEPT 4¾													15 per day — No Black Bass under 9 ins. No sale Hook and line only
	CLEAR LAKE IN LAKE CO.													Clear Lake 10 per day
Sunfish	ALL													25 per day
Sacramento Perch and Crappie	ALL EXCEPT CLEAR LAKE													25 per day — Hook and line only No sale
	CLEAR LAKE													10 per day
Striped Bass	1-2-12A													None under 12 inches, 5 per day. None to be taken from Salton Sea. See Note 15
Crabs	ALL EXCEPT 1½-6-7-8-9							30					15	Season Districts 1½-6-7-8-9 August 31, December 14 See Note 24. None under 7 inches. No Female
Abalones	ALL	14			16									Only the foot. Must be brought to shore alive in shell Angling License Required. See Note 27
Pismo Clams	17													None under 5 inches. No shipment. 15 per day Angling License Required. District 18a Closed
Spiny Lobster	ALL										15			No Sale of Meat. None under 10½ or over 16 inches See Note 24
GRUNION	ALL													

Salmon and Shad May Be Taken as Noted in Paragraphs 19-23. No open season on Sturgeon (possession prohibited).

NOTES

IT IS ALWAYS UNLAWFUL

1. To hunt, kill, possess wild birds or mammals, to possess firearms, except under written permit from the Commission, within districts 1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h, 1i, 1j, 1k, 1m, 1n, 1o, 1p, 1q, 1r, 1s, 1t, 2a, 2b, 3a, 3b, 3c, 3d, 3e, 3f, 3g, 3h, 4a, 4b, 4c, 4d, 4e, 4f, 4g, or General Grant Refuge, or the Mt. Tamalpais Game Refuge, including Richardson Bay, or San Francisco Refuge, or Silver Lake Refuge (water fowl may be killed in 4a and 4e), or to hunt quail in the Bolinas Quail Refuge, or to hunt or discharge firearms in Huntington Lake Refuge or San Leandro Bay Refuge.

2. To hunt birds or mammals excepting predators without a hunting license.

3. To possess any bird net or to set, trap or to hold protected game or birds of any kind, their nests or eggs except under written permit from the Commission.

4. To take or possess more than 8 geese per day or 50 per week; or more than 8 honkers or sea brant per day or 24 per week.

5. To take or kill non-game birds, except blue jay, butcher bird, English sparrow, sharp-shinned, Cooper or duck hawk, great horned owl, linnet, white pelican, shag, and in districts 1, 2, 3, 4 and 4½, blackbirds.

6. To hunt deer without a deer tag license. To fail to attach to the horns of deer immediately on killing, properly filled out license tag or at the same time to send duplicate tag to the Division. To carry a deer into a closed district without having license tag countersigned, or to have untagged deer in possession. To fail to retain in possession during open season and for ten days after the skin and portion of head bearing horns of deer killed and to produce upon demand. To use more than one dog to the hunter in hunting deer or to allow dogs to run deer in closed season, or to possess doe or fawn skins, or deer skins not bearing evidence of sex.

7. To trap for profit bear, ring-tailed cat, coon, pine marten, skunk, fisher, wolverine, mink, river otter, fox, beaver or muskrat, or to kill these animals during the closed season, except when destroying property. To interfere with the traps of licensed trappers. To use saw tooth or spike jawed traps for taking fur bearers.

8. To use any animal other than a dog to stalk wild birds.

9. To shoot game from a power boat, sailboat, auto, airplane; or to hunt waterfowl from a scull boat in districts 8, 9, except on Wednesdays and Sundays, or at any time in district 13 or Napa River south of Edgerly Island, or to use a

shotgun larger than ten gauge, or to possess an extension automatic or a cane gun.

10. To shoot resident game between ½ hour after sunset and ½ hour before sunrise, or migratory game between sunset and ½ hour before sunrise. To use a spotlight in hunting game.

11. To hunt waterfowl in districts 4, 4½, 4a, 4c, 19, 20, 20a, 22, other than on Wednesdays, Saturdays, Sundays, legal holidays, opening and closing days; or in district 4a except between 8 a.m. and sunset. To drive game birds by means of auto, airplane, or power boat over shooters.

12. To hold game or fish longer than 5 days after close of season, venison 15 days.

13. To sell wild game, except cottontail and brush rabbits.

14. To make a false statement in applying for license. To fail to show license upon demand to any officer.

15. To take game or fish from one district to another when season is not open in both. (Special law for deer and trout.) Trout legally taken may be transported from an open district into a closed district by the consignor making an affidavit in duplicate setting forth his name, address, number of angling license and name and address of consignee. The original must be attached to the shipment, the copy left on file with the officer before whom sworn. Trout may be shipped into closed district when accompanied by written statement to the effect that trout were legal, signed by shipper, countersigned by agent to whom offered for shipment.

16. To ship wild birds, mammals, or fish except smoked or dried fish other than trout by parcel post, or in concealed packages or without a tag bearing name and address of consignee and consignor and contents, or to ship game out of state.

17. To operate a commercial hunting club without license.

18. To place obstructions in streams in districts 1, 1½, 2, 2½, 3, 4, 4½, 23, 24, and 25 that will stop or impede fish.

19. To buy, sell or ship striped bass less than 20 inches in length, or to ship striped bass out of state, or to ship striped bass during closed season; to take other than with hook and line. To possess more than five shad per day between May 16 and July 31, or September 17 and November 14.

20. To take trout other than with rod and line held in the hand or with lure with more than 2 attractor blades or more than 3 hooks.

21. To have in possession any fish spear or gaff (except landing gaff) within 300 feet of any lake or stream when unlawful to spear salmon.

22. To take trout in any lake within 300 feet of the mouth of any stream from October 31 to August 1, or in that portion of any stream flowing into any lake in Districts 23 and 24 within two miles from its mouth, upstream, from October 31 to August 1.

23. To take salmon on spawning beds or within 10 miles of a spawntaking station or 3 miles north and south of mouth of Klamath River; to take in ocean and Humboldt Bay districts Chinook less than 27, or Silver less than 24 inches, or to gaff or club undersized salmon, or to bring ashore in such condition that the size can not be taken, or to not have a landing net in any salmon boat. To take more than 2 salmon per day in districts 1, 1½, 2, 2½, Klamath River (above tidewater), 3, 12a, Klamath River tide except between July 1-September 5; to spear salmon except in districts 1, 1½, 2, 2½, Klamath River above tidewater; to take salmon in any way except between dates given—district 1 May 29-October 31; 1½, Klamath River May 29-December 31; 2, 2½, May 1-February last; 3, 12a May 1-October 31; to take or possess salmon except between dates given—districts 6, 7, 8, 9, May 1-September 15; districts 10, 11, May 1-August 15; districts 15, 16, 17, 18, April 1-June 30; to spear salmon except between dates given—district 1 May 29-October 31; 1½ and Klamath River above tide August 1-October 31; 2, 2½ November 1-February last.

24. To bring to shore crabs or lobsters in such condition that the size can not be taken; or to ship or carry crabs out of districts 1½, 2½, 5, 6, 7, 8, or 9.

25. To take or possess in district 3 salt water eels of less than 12 inches or more than 15 per day.

26. To take or possess cockles less than 1½ inches in diameter, or to take or possess more than 15 (Dist. 10) Washington clams or more than 10 horse clams or more than 30 razor clams per day, or in districts 18, 19, 21 more than 15 pounds of mussels per day.

27. To take red abalones less than 7 inches in the greatest diameter; green, 6½; pink, 6; black, 5; to dry abalones; to dive for abalones in districts 7, 15, 16, 17, 19, 20 and 20a; to take more than 10 per day or 20 per week in districts 7, 15, 16, 17, 18, 20 and 20a. To take more than 10 per day from shore in districts 7, 10 and 18; to take more than 10 black abalones per day in districts 14, 15, 16, 17, 18, 19, 20, 20a, 21.

28. To fish for game fish without having an angling license.

29. To take game fish between 1 hour after sunset and 1 hour before sunrise in districts 1, 1½, 1½, 2, 2½, 3, 4, 4½, 4a, 23, 24, 25.

30. To fish with nets except in commercial districts.

31. To fish through the ice for any fish or to take fish in district 14.

32. To place, cause to be placed, or discharge into any waters substances deleterious to fish or plant life.

33. To fish within 250 feet of a fishway or 150 feet of the upper side of a fish screen, or the lower side of a dam, or to take fish except salmon within ½ mile of the lower side of a spawning station, or any lake within ½ mile of a spawning station when station is in operation.

34. To kill, injure or capture California sea lions in districts 19, 20, 20a.

35. To take invertebrates or marine plants in Hopkins Marine Refuge (Monterey Co.) or in that area between the west line of the property of the Scripps Institute and a line 1,000 feet west of low tide line (San Diego Co.).

36. To take more than 5 white sea bass from May 1 to June 30, or to take at any time more than 5 under 28 inches.

37. To take more than 30 pounds of halibut under 4 pounds each, or to take more than 5 barracuda less than 3 pounds each.

LICENSES MUST BE SHOWN UPON DEMAND

Districts 1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h, 1i, 1j, 1k, 1m, 1n, 1o, 1p, 1q, 1r, 1s, 1t, 2a, 2b, 3a, 3b, 3c, 3d, 3e, 3f, 3g, 3h, 4a, 4b, 4c, 4d, 4e, 4f, 4g, are Game Refuges. Hunting prohibited. Angling in accordance with law relating to main districts in which refuge is located.

Districts 5, 6, 7, 8, 9, 10, 11, 12, 12a, 12b, 12c, 13, 16, 17, 18, 19, 19a, 20, 20a, 21, 22, are Commercial Fishing Districts. Hunting and angling in accordance with law relating to main district in which small district is located.

District 14 is a Fish Reservation. All fishing prohibited.

District 2½ includes those townships in Mendocino County bordering on the Pacific Ocean (except 15 and 16 W., 11 N.) and townships 13, 14, 15, 16, 17 and 18 N., R. 16 W.

District 23. The water shed of Lake Tahoe and Truckee River, Rubicon and Little Rubicon above confluence water shed of American River and Silver Creek above confluence.

District 24 includes waters in watershed of Cosumnes above mother lode highway bridge, waters of South Fork American River between Chili Bar Bridge and mouth of Silver Creek; the waters of the Carson, West Carson and all interior lakes, Twin lakes, Silver, Twin, Blue, Meadow, Wood, Winnemucca, Beetl, Burnside Lake and all tributary streams

LICENSE PROVISIONS

HUNTING

License year after July, 1931, July 1 to June 30

Residents under 18	$1.00
Resident citizens	2.00
Non-resident citizens	10.00
Declarant Aliens	10.00
Other Aliens	25.00

On account of change in hunting license year, cost of license from January 1, 1932, to June 30, 1933 (18 months), will be 1½ times above schedule.

ANGLING

License year January 1 to December 31

Resident citizens	$2.00
Non-resident citizens	5.00
Aliens	5.00

Under 18 no license required

TRAPPING

License year July 1 to June 30

Citizens	$1.00
Aliens	2.00

Under 18 no license required

DEER TAG

License year January 1 to December 31

Everyone (2 tags)	$1.00

COMMERCIAL HUNTING CLUBS

License year July 1 to June 30

Citizens	$25.00
Aliens	100.00
Operators, citizens	5.00
Operators, aliens	25.00

For Laws in Full See Penal Code.

For Commercial Fish Laws See Commercial Abstract.

For Information Regarding Fish or Game Write to the Division of Fish and Game

BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol.....San Francisco
K. P. Allred, Assistant Chief of Patrol.....San Francisco
C. S. Bauder, Assistant Chief of Patrol.....Los Angeles
Walter R. Welch, Captain, in Charge Volunteer Wardens.....San Francisco

SAN FRANCISCO OFFICE
J. L. Bundock.....Oakland
M. S. Clark.....Niles
T. K. Duncan.....Concord
C. E. Holladay.....San Jose
M. F. Joy.....San Francisco
Orben Philbrick.....Monterey
McPherson Lough.....Palo Alto
Forrest J. McDermott.....Santa Cruz
C. R. Peek.....San Mateo
Fred Post.....Salinas
Paul Turner.....King City
Lee C. Shea.....San Francisco
J. P. Vissiere.....Watsonville

WM. LIPPINCOTT.....San Rafael

L. T. WARD.....San Rafael
Lee Atkinson.....Pittsburg
W. J. Black.....Vallejo
C. M. Bouton.....San Rafael
C. L. Bundock.....Fairfield
Chas. F. England.....Vallejo
Bert F. Laws.....San Rafael
R. J Yates.....San Anselmo

A. H. WILLARD.....Sacramento Office
Earl I. Hiscox.....Auburn
Ray O'Connor.....Grass Valley
Nelson Poole.....Sacramento Office
Albert W. Sears.....Placerville
Chas. Sibeck.....Sacramento Office
R. L. Sinkey.....Woodland

WM. J. HARP.....Arcata
Ed. Clements.....Klamath
John Hurley.....Crescent City
Ed Johnson.....Garberville
Scott Feland.....Fortuna

S. R. GILLOON.....Mt. Shasta
C. R. Love.....Redding
Brice Hammack.....Yreka
A. A. Jordan.....Alturas
R. C. Marshall.....Douglas City
Paul Kehrer.....Adin
Fred Starr.....Macdoel

S. J. CARPENTER.....Maxwell
Roy W. Anderson.....Red Bluff
E. O. Wraith.....Chico
W. C. Blewett.....Colusa
L. W. Dinsdale.....Yuba City
W. F. Kallher.....Willows
Taylor London.....Oroville

J. D. DONDERO.....Lakeport
Earl Caldwell.....Covelo
Ovid Holmes.....Fort Bragg
Geo. N. Johnson.....Napa
Earl Macklin.....Ukiah
Ray Diamond.....Willits
L. A. Mitchell.....Point Arena
K. J. Ransdell.....Napa

HENRY LENCIONI.....Santa Rosa
J. H. Groves.....Cloverdale
V. E. Vox Arx.....Santa Rosa

JOSEPH H. SANDERS.....Truckee
C. O. Fisher.....Susanville
W. I. Long.....Westwood
L. E. Mercer.....Quincy
F. F. Johnston.....Beckwourth

J. E. NEWSOME.....Newman
H. E. Black.....Madera
C. L. Brown.....Mariposa
C. L. Gourley.....Gustine
L. W. Longeway.....Sonora
Geo. W. Magladry.....Modesto
R. A. Tinnin.....Aawater

J. O'CONNELL.....Stockton
Alvin Granstrom.....Lodi
Wm. Hoppe.....Tracy
Geo. R. Smalley.....Tracy
Lee Straight.....Walnut Grove
Vernon Sutton.....Angels Camp
J. W. Thornburg.....Markleeville

E. W. SMALLEY.....Hanford
F. A. Bullard.....Reedley
Ray C. Ellis.....Fresno
R. J. Little.....Auberry

O. P. BROWNLOW.....Visalia
Lester Arnold.....Bakersfield
Ray J. Bullard.....Porterville
Roswell C. Welch.....Kernville
E. C. Vail.....Dinuba

LOS ANGELES OFFICE
W. E. Adkinson.....El Toro
A. R. Ainsworth.....Santa Maria
R. E. Bedwell.....Ventura
C. S. Donham.....Escondido
E. H. Glidden.....San Diego
W. R. Goff.....Paso Robles
J. H. Gyger.....Perris
J. W. Harbuck.....Brawley
W. L. Hare.....Santa Ana
F. W. Hecker.....San Luis Obispo
H. C. Jackson.....Santa Barbara
T. R. Jolley.....Idyllwild
W. S. Talbott.....Westmoreland
C. L. Towers.....Los Angeles

LARUE F. CHAPPELL.....Pasadena
H. S. Vary.....Newhall
W. C. Malone.....San Bernardino
C. L. Savage.....Los Angeles

E. H. OBER.....Bishop
A. F. Crocker.....Bridgeport
Eugene Walker.....Independence
C. J. Walters.....Independence

COMMERCIAL FISHERIES PATROL

S. H. LYONS, Supervisor Fisheries Patrol.....Terminal Island
C. H. GROAT, Captain.....Terminal Island
R. F. CLASSIC, Captain.....Monterey
COBURN F. MADDOX, Captain.....San Diego

N. C. Kunkel.....Terminal Island
Ross W. Markley.....Terminal Island
Tate F. Miller.....Terminal Island
T. W. Schilling.....Pismo Beach
T. J. Smith.....San Diego

Launch Patrol

Walter Engelke.....Motor Vessel "Bluefin," Terminal Island
Hugo I. Cairen.....Motor Vessel "Bluefin," Terminal Island
Harry A. Lynch.....Motor Vessel "Bluefin," Terminal Island
L. J. Weseth.....Launch "Albacore," Monterey
Erol Greenleaf.....Launch "Albacore," Monterey
C. M. Bouton.....Launch "Quinnat," San Rafael
W. J. Black.....Launch "Hunter," Vallejo
Wm. Hoppe.....Launch "Rainbow," Walnut Grove
Lee Atkinson.....Launch "Walter R. Welch," Pittsburg
Ed. Clements.....Launch "Silverside," Klamath

Captains indicated in capitals.

CALIFORNIA STATE PRINTING OFFICE
HARRY HAMMOND, STATE PRINTER
SACRAMENTO, 1933